REFINING • PETROCHEMICALS • NATURAL GASOLINE

Petroleum Refiner

MAY
1957

YOUR REPORT ON API PAPERS

When to Isomerize C_5's and C_6's 172

How to Make 110 Octane Premium 193

How Humble Runs Its Reformers 189

Low vs. High pH in Crude Units 199

PLAN YOUR PROCESSING

What Will Future Octane Numbers Cost? 209

OPERATING REPORT

Catcracking with High Alumina Catalyst 231

A NEW APPROACH

How to Limit Maintenance Costs Today 235

For a "Quick Look" at this issue, turn the page . .

SUBSCRIPTION PRICE $2 PER YEAR
SINGLE COPY PRICE 50 CENTS

STREAM BLEND LUBES...

pay-out proven!

NO SLOP . . . NO NEED TO DOWN-GRADE . . . AUTOMATIC BLOWBACK eliminates slop when base stocks and additives are realigned.

ACCURACY . . . CLOSED CONTROL LOOP PRINCIPLE AND PNEUMATIC SYSTEM eliminating back-loading of meters, give instantaneous control response. Memory feature inherent in control system assures correct end product. Recirculation system permits formulation check prior to blending.

FAIL-SAFE OPERATION . . . ELECTRICAL INTERLOCK SYSTEM provides "fail-safe" operation and isolates blend manifold on departure of any component from set formulation.

VERSATILITY . . . TOTAL OUTPUT RATE quickly adjusted to suit production requirements without affecting blend ratio.

EASE OF EXPANSION . . . UNITIZED CONSTRUCTION permits future expansion at minimum cost. Built-in totalizers provide continuous performance and inventory check.

ONE USER TESTIFIES after only 6 months of operation, "The savings effected to date . . . represent better than one-third the cost of the plant."

ONE USER ALSO TESTIFIES . . .

"Our Proportioneers blending machine has proven to be extremely accurate (will hold a 78 SUS at 210°F viscosity oil within plus or minus 0.3 SUS). It is also very dependable, easily controlled, reasonably foolproof, and impressive in appearance. We are very well satisfied with it."

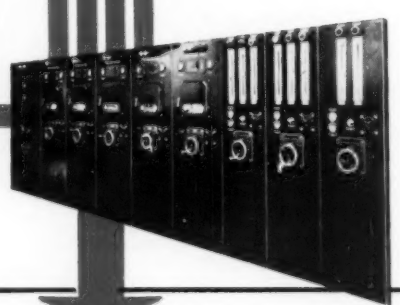
"The unique 'test blend' and component totalizing features incorporated in the Proportioneers blending machines are extremely useful and excellent safeguards. Such features take on even greater importance where operating personnel are limited in experience and know-how."

"'Slop losses' due to carryover can be reduced practically to zero."

"Such machines (Proportioneers LUBE OIL BLENDERS) are justified by reduced labor, more continuous production, reduced floor space, better control of production, ease of expansion, and greater sales appeal."

FURTHER JUSTIFICATION . . .

Let one of our sales engineers show you how a Proportioneers Blender can justify pay-out on 50,000 barrels or more annually. Request Bulletin SM-2055 for complete data.



Write to
PROPORTIONEERS, INC.
412 Harris Avenue,
Providence, R. I.

PROPORTIONEERS, INC.
DIVISION OF
B-I-F INDUSTRIES
PROVIDENCE, RHODE ISLAND
B-I-F METERS FEEDERS CONTROLS

Volume 36, No. 5 May, 1957

API SECTION

When to Isomerize C_5's and C_6's 172
H. R. Grane, J. K. Ozawa and G. R. Worrell
Isomate Process Adapted to Motor Fuels 177
H. G. Krane and E. W. Kane
Upgrading with Dehydrogenation 183
H. Shalit, F. W. Kirsch, W. S. Briggs and J. B. Maerker
Upgrading Low-Boiling Saturates 186
C. K. Donnell, A. Schneider and D. H. Stevenson
How Humble Runs Catalytic Reformers 189
H. C. Nix
How to Make 110 Octane Premium 193
S. P. Blumberg
Low pH vs. High pH in Crude Oil Units 199
J. A. Biehl and E. A. Schnake
Survey Reveals Reformer Corrosion Data 201
E. B. Backensto
Gas Chromatography Steps Out 205

OTHER TECHNICAL FEATURES

How Much Future Octanes Will Cost 209
S. W. Curry
How Kaolin Works for Cat Cracking 213
D. Beyler, J. B. Maerker and J. W. Schall
Taking Stock 216
Cecil W. Smith
Urea Dewaxing Gets More Emphasis 217
T. H. Rogers, J. S. Brown, Robert Diedman and G. D. Kerns
Low Pour Oils Made by Urea Process 221
Ing. A. Hoppe and H. Franz
How to Test Condensers 225
Cracking with High Alumina Catalyst 231
R. W. Roquemore and C. D. Strickland
Make Drum Sizing Easier 234
C. A. Petrarca
New System for Maintenance Control 235
B. A. Margo
Get Dew Points Easily 238
Max F. Mueller
Compare Finned and Plain Tubes 239
Merk Hobson and James H. Weber
Centrifugal Pump Packings and Seals (Part 4) . 243
Harold Woodhouse
Propane Removes Asphalts from Crudes 247
H. N. Dunning and J. W. Moore
Steam Batch Distillation Calculations 251
C. D. Holland and N. E. Welch
TV Stands Guard 254
Solubility of Water in Hydrocarbons 255
W. F. Hoot, A. Azarnoosh and John J. McKetta
Domestic Crudes Contain Less Sulfur 257
E. M. Shelton, C. M. McKinney and O. C. Blade
Fluid Catalyst Design Data (Part 2) 261
Frederick A. Zenz
Wasted Power in Natural Gasoline Plants 266
Homer C. Givens

As Management Sees It . . .

Streamline Your Workload 301
Robert E. Johnson
How to Handle and Store Jet Fuels (Part 5) 304
J. L. Risinger
How Well Do You Communicate? 312
Anatol Rapoport

DEPARTMENTS

Mail Box 158
Quick Look at Industry . . 163
Look Box 167
Valuable Reading Ahead 270
Reviewing New Books . . 272
How To Do It 274
Who's Building 283
If Oil Could Speak 333
What's Happening 335
Meeting Calendar 354
Men In Industry 357
Suppliers Notes 374
Classified Advertising . . . 400
New Equipment 402
Manufacturers' Literature 402
Index to Advertisers 413

Petroleum Refiner
REFINING • PETROCHEMICALS • NATURAL GASOLINE

A Quick Look

at This Issue

These handy digests permit checking those articles you want to read first. ☑

API SECTION

☐ **When to Isomerize C_5's and C_6's . . .** Hypothetical case in this article shows that it pays to add isomerization when gasoline pool reaches 97.8 octane. To get a clear picture of isomerization economics, turn to . . . . . **Page 172.**

☐ **Isomate Process Adapted to Motor Fuel . . .** This World War II isomerization process for making avgas has been improved for upgrading C_5's and C_6's. It uses an $AlCl_3$ complex catalyst and operates at lower temperatures than other isomerization processes. For how it works and what it costs, turn to **Page 177.**

☐ **Upgrading Pentanes with Catalytic Dehydrogenation . . .** This process can produce higher octane ratings from C_5 fractions than those possible by isomerization. Yields, though, are less than isomerization for octane ratings up to isopentane. Turn to . . . . . **Page 183.**

☐ **Upgrading Low-Boiling Saturates with Dehydrogenative Reforming . . .** This process can be used to upgrade C_6-C_8 from BTX production and light reformate from catalytic reformers. These fractions are now limiting in most refiners' pools. **Page 186.**

☐ **How Humble Runs Catalytic Reformers . . .** Successful regeneration techniques in two Humble platinum reformers give a catalyst life of two years. They normally produce a 93 octane reformate but have been operated up to 100 octane. . . **Page 189.**

☐ **How to Make 110 Octane Premium . . .** Compression ratios continue their upward climb and demand for higher octane fuels increases. Just how the refiner can go about changing his processes to meet this demand for premium fuels is a problem of primary importance. Here is one approach showing four steps in eventually reaching the expected octane requirements. Check your plans against this article. Turn to . . . . . **Page 193.**

Please Turn Page ➔

A Quick Look at This Issue . . .

☐ **Low pH vs. High pH in Crude Oil Units . . .** Here's a report of the results obtained by maintaining high-pH and low-pH in a crude unit's overhead receiver water. .....Page 199.

☐ **Survey Reveals Reformer Corrosion Data . . .** This panel report on a 31-company survey shows the most frequently encountered difficulties related to reformer corrosion.....Page 201.

☐ **How Much Future Octanes Will Cost . . .** The hypothetical refinery described in this article shows an attractive pay-out for step-wise octanes to 101 pool gasoline. The trick will be to add processes in the most economical order.....Page 209.

☐ **How Kaolin Works for Cat Cracking . . .** Kaolin is compared with bentonite clays and synthetic catalysts. See the commercial and pilot plant data for these comparisons by turning to....Page 213.

☐ **Urea Dewaxing Gets More Emphasis . . .** Learn some of the points which were considered before urea dewaxing was put into commercial operation for low-cold-test oil production.....Page 217.

☐ **Low Pour Oils Made By Urea Process . . .** Here is the description of a German plant which uses urea to extract a low pour point oil. To see why no refrigeration is needed for this plant, turn to **Page 221.**

☐ **How To Test Condensers . . .** Here's a proposed AIChE standard that outlines the procedure for testing performance of shell and tube type condensers. For complete details, turn to...Page 225.

☐ **Cracking with High Alumina Catalist . . .** Here is a report of a refinery which switched its fluid catalytic cracking unit to a 25 percent alumina catalyst. .....Page 231.

☐ **Make Drum Sizing Easier . . .** No more trial-and-error calculations are required to get the dimensions for horizontal drums. Use the chart on **Page 234.**

☐ **New System for Maintenance Control . . .** Here's a method that allows you to *calculate* the limits of tolerable maintenance so that you will *know* when maintenance costs become excessive. **Page 235.**

☐ **Get Dew Points Easily . . .** To find dew points of vapors at elevated pressures, use the handy nomograph on.....Page 238.

☐ **Compare Finned Tubes With Plain Ones . . .** In the selection of extended surface tubes for heat exchangers, the benefits of increased heat transfer must be balanced against the increased pressure drop. Several methods of comparing tubes start on **Page 239.**

☐ **Centrifugal Pump Packings and Seals . . .** Here's a complete report on the cause of mechanical seal troubles, what to look for, and how to remedy these problems.....Page 243.

☐ **Propane Removes Asphalts from Crudes . . .** A batch method may be used to study the effects of temperature and propane-oil ratios for a propane-deasphalting process. The results may then be applied to counter-current towers. To learn the optimum values for these variables, turn to **Page 247.**

☐ **Steam Batch Distillation Calculations . . .** A NEW method for multicomponent mixtures which you will like. The entire development of this new relation is included.....Page 251.

☐ **TV Stands Guard . . .** Here a new method is used to guard the employe entrance of a refinery. To learn how TV and remote control are used so that no watchman is seen, turn to.....Page 254.

☐ **Solubility of Water in Hydrocarbons . . .** Whenever you want this sort of information it usually means a long search through the literature. The authors have combined the solubility data of 17 different pure hydrocarbons and petroleum fractions on one convenient graph. See.....Page 255.

☐ **Domestic Crudes Contain Less Sulfur . . .** The sulfur content of crude oil is useful information in deciding the type of processing which will be required. To see what concentration of sulfur to expect in U. S. crudes, turn to.....Page 257.

☐ **Fluid Catalyst Design Data (Part 2) . . .** Particle size distribution for desirable fluidization effects is still based on qualitative field experience. Here are the few published data drawn into a logical pattern to permit quantitative treatment. An analytical definition of an optimum particle size distribution which approaches the skew probability form, having approximately an eleven-fold variation in particle size is the result. This is for your fluid catalyst design workbook. **Page 261.**

☐ **Wasting Power? La Gloria Found These Sources . . .** Three sources of power that can be wasted in your natural gasoline plant are expanding gas, rich absorption oil and exhaust steam. Turn to .....Page 266.

☐ **Streamline Your Work Load . . .** There are are four deadly time destroyers in every executive's office: The desk—letter box—telephone—and visitor's chair. Here are practical ways to transform these time losers into time savers.....Page 301.

☐ **How to Handle and Store Jet Fuels . . .** Jet fuels are as safe as any other product if proper precautions are taken. Here is the fifth installment in this comprehensive report by one of the nation's top fire authorities. Turn to.....Page 304.

☐ **How Well Do You Communicate? . . .** Success or failure of refinery management-employe communications depends on one factor—ability of one group to describe and share similar experiences with the other group. This is just as true with individual communicants. For a thought-provoking discussion on the best ways to "say what you mean," turn to **Page 312.**

Petroleum Refiner

RAY L. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
SILAS B. RAGSDALE.....Editorial Director
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
GEORGE B. GIBBS.....Editor
FRANK L. EVANS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
DON E. LAMBERT.....Management and Personnel Editor
CECIL W. SMITH.....Economics Editor
HARRISON T. BRUNDAGE.....Eastern Editor
GILBERT M. WILSON.....Western Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
JACK COCKERHAM.....Presentation Editor
CLAYTON A. UMBACH, JR.....Editorial Assistant
BEVERLY DRAWE.....Editorial Assistant
EUNICE OKONESKI.....Librarian

ADVERTISING

HOUSTON 19: Tom W. Nelson, Jack Walker, Charles Wyatt, Wm. G. Dudley, 3301 Buffalo Drive, Phone JAckson 9-4301; NEW YORK 17: Gene Hart, George Skelton, Nelson Bigelow, 250 Park Ave., Phone YU 6-6558; CLEVELAND 15: Harvey Dunn, Bill Westfall, 1010 Euclid Ave., Phone MAin 1-3295; CHICAGO 4: Martin Halloran, H. G. Fitzpatrick, 332 S. Michigan Ave., Phone Wabash 2-9330; LOS ANGELES: Jay Curts, W. W. Wilson Bldg., Huntington Park, Phone Ludlow 7-1219; TULSA 3: Jim Isaacks, 916 Enterprise Bldg., Phone CH 2-9211; DALLAS 2: Ed Thompson, 518 Second Unit Santa Fe Bldg., Phone Riverside 7-7344. EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31. Hannover, Germany, Phone 42935. UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2. Phone Monarch 5661. Advertising rates on application. Cable address: GULFPUBCO, Houston.

SUBSCRIPTIONS

R. M. de Sombre, Circulation Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues) for domestic and foreign. Double price for copies over one year old. Subscription rates—both foreign and domestic $2 a year. Subscriptions restricted to those engaged in refining, natural gasoline or petrochemical industries or service and supply company personnel connected thereto. PETROLEUM REFINER, published on the 12th of each month, entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879. Copyright 1957 by The Gulf Publishing Company.

Specialized Oil Publications of
THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the refining, natural gasoline, petrochemical industry.

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

One Reason We Rate

ONE OF OUR EDITORS was quite amazed a few months back when a man he was visiting in the offices of a petrochemical company advanced the thought that we ought to get some engineers on our staff. In fact, he waved his arm to include ALL refining and petrochemical publications periodicals. Their material, he felt certain, would be much more authentic and usable if this were the case.

Of course there are a lot of things we don't know about *his* business, but it was something of a revelation to find a man in his position who didn't know that the staffs of such magazines are loaded, so to speak, with engineers. In our own case, we have a Ph.D. in addition to a Master's and two Bachelor's—all in chemical engineering. Then, for the Maintenance post, we have a graduate mechanical engineer. Besides their degrees, all of these men have had industry experience.

So technical material in PETROLEUM REFINER has been through the hands specified by our friend.

Top Topic in June

WITHIN THE LAST FEW YEARS, there has been an ever increasing interest in cathodic protection. But many of the articles published on the subject cover only the fundamentals.

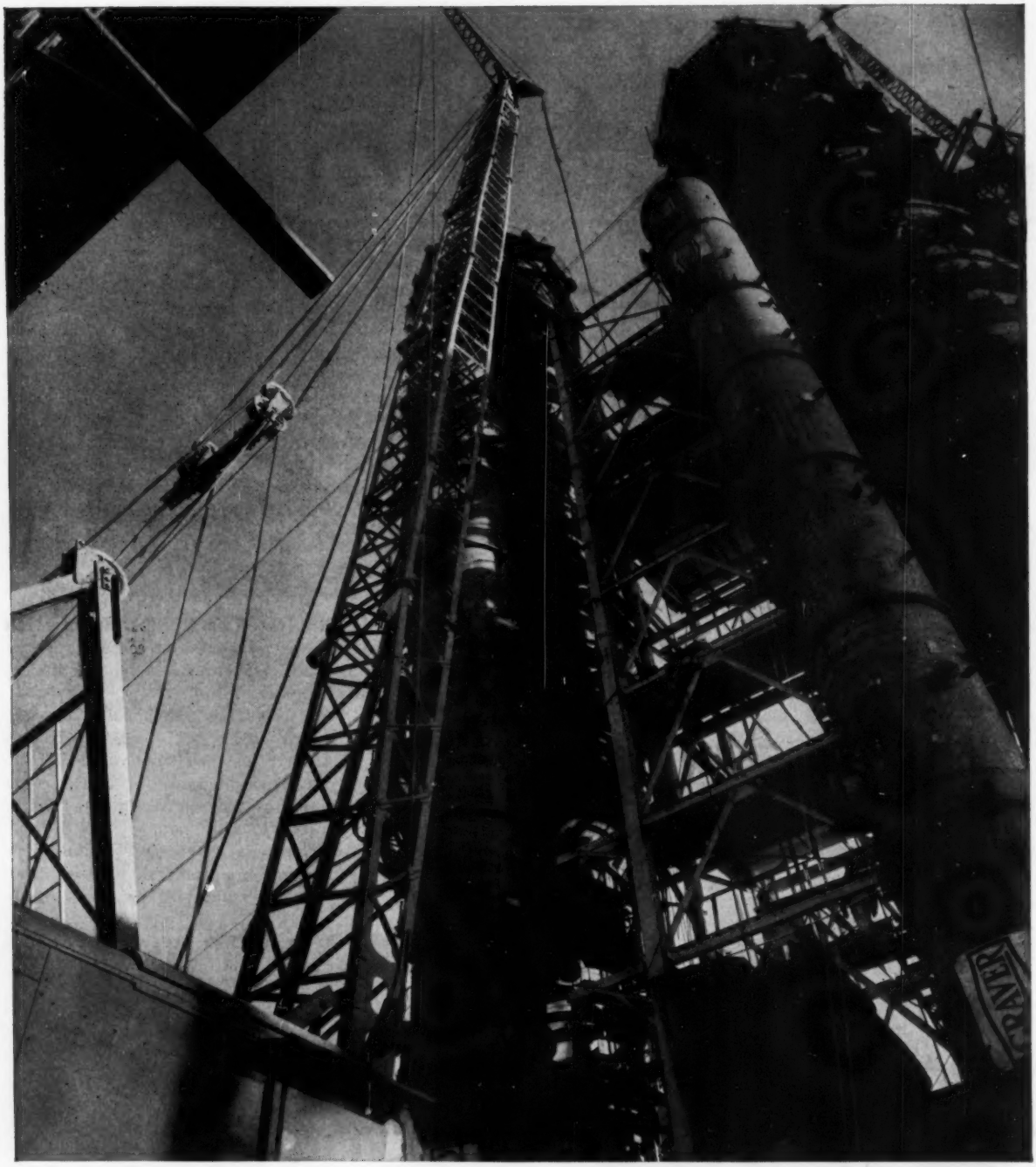
Engineers with The Dow Chemical Company, Freeport, Texas, have developed a technical handbook on this subject. From their years of experience, they will present practical methods of calculating the cathodic protection required, for various conditions, and how much it costs to do the job.

Cathodic protection is not a cure-all for anywhere near all of your corrosion problems. But, its value under certain corrosive conditions has been firmly established.

PETROLEUM REFINER's June issue will contain this entire handbook as a special report.

Handy Handbook

OUR "AUTHOR'S HANDBOOK," a handy little piece designed for those who want to write as well as those who do, continues to be popular. We've told you in the past how sections from it were to be used in an expanded revision of a college textbook, "Engineer's Manual of English." And how another technical journalism college professor asked for copies to be given to students who are preparing for trade and technical writing. "One of the finest presentations I've seen," is what he said. Now another Eastern College prof, about to go into a short course for professional technical writers, asks for a supply so that each "student" may have one. We have developed—and found—some additional ideas that we propose using in the third edition of the Handbook, but until it comes along No. 2 stands to do you a lot of good. Why not request a copy? It's free. Just address our Editorial Director, Box 2608, Houston.



NEW MONUMENTS TO EFFICIENCY!

These huge stripper columns were produced with typical Graver craftsmanship. Shop fabricated from ASTM A-285 Grade C firebox quality steel, they represent one of many types of processing equipment Graver has been fabricating for 100 years.

1857-1957 GRAVER Our 100th Year

Building for the Future on a Century of Craftsmanship in Steels and Alloys

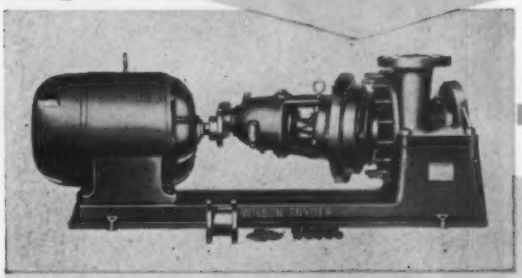
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA • NEW YORK • PHILADELPHIA • EDGE MOOR, DELAWARE
PITTSBURGH • DETROIT • CHICAGO • TULSA • SAND SPRINGS, OKLAHOMA
HOUSTON • LOS ANGELES • FONTANA, CALIFORNIA • SAN FRANCISCO

For more data on advertised products, use Readers' Service Cards, last page.

At the All New Yorktown, Va. Refinery of American Oil Company

82 Wilson-Snyder ES Centrifugal Process Pumps... like this



Particularly designed for Processing Services at high temperatures to 900° F., high vapor pressures to 600 psi, and high discharge pressures to 750 psi.

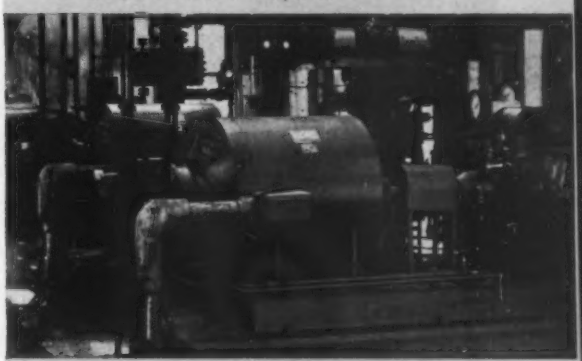
Available in 20 sizes from 15 to 2,000 GPM, 50 to 1,100 foot head, and 2 to 250 horsepower.

...perform a wide variety of processing services!

Very few pumping jobs are exactly alike. Each application involves various combinations of capacities, temperatures, differential heads and liquids with their individual characteristics and material requirements. Typical applications are illustrated here.

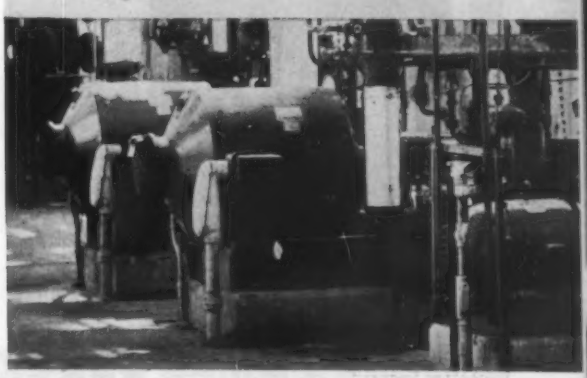
Yet... in addition to the broad capacity, temperature, and head range at high efficiency and the extra long service life that is inherent in Wilson-Snyder Centrifugal Process Pump design . . . a surprisingly small inventory of maintenance parts is required to service all sizes. Only THREE SIZES of bearing bracket assemblies, including shafts, sleeves, bearings and packing need be stocked to service all of the TWENTY pump sizes in the line.

This is why so many users are finding it extremely economical and practical to standardize on these pumps for all requirements within the scope of their application.



These Vacuum Tower Intermediate Reflux Pumps (size 6x8x10½" ES — Top Suction) handle Hot Oil of .672 specific gravity at 550° F. pumping temperature with 318 ft. differential head with capacity range from 1365 to 1570 GPM with 150 HP driving motors.

On the "Cat Cracker" Unit, these pumps (size 3x4x16" ES — Top Suction) handle Low Pressure Distillate of .739 specific gravity at 100° F. pumping temperature with 815 ft. differential head and capacity of 254 GPM with 150 HP driving motors.



Specify Wilson-Snyder process pumps for your requirements

OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION
Executive Offices—**DALLAS, TEXAS**

with Refinery Equipment Specialists at

Calgary, Canada	Houston, Texas	Los Angeles, Calif.
Dallas, Texas	New York, N. Y.	Odessa, Texas
Chicago, Illinois	Braddock, Pa.	Tulsa, Okla.
	Corpus Christi, Texas	

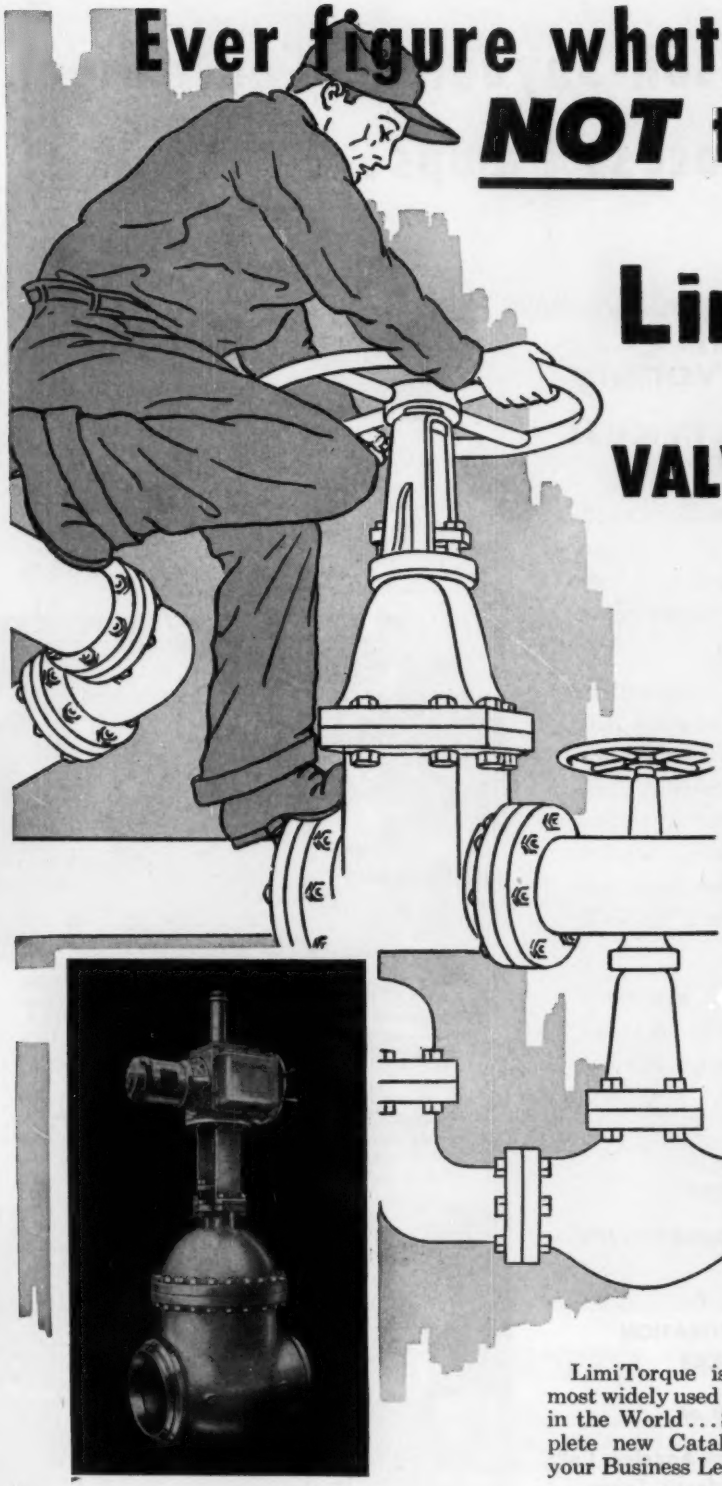
Branches Serving All Oil Fields

"OILWELL"
TRADE MARK

UNITED STATES STEEL

Ever figure what it costs **NOT** to use

LimiTorque® *Automatic* VALVE OPERATION?



How much does opening and closing Valves *by hand* cost you—in man-hours—in physical danger to workmen who must climb to high or dangerous locations?

How much time, labor, and money could be saved in your plant by opening and closing valves *automatically*—at correct operating speeds—by the mere "push of a button"? With LimiTorque, one finger does the work of many hands. LimiTorque control permits one man to operate, and know the exact position of each valve from a central, conveniently located control panel.

LimiTorque protects valve seats, discs and stems from damage, by automatically shutting-off power source, should an obstruction interfere with valve closing.

Valves operated by LimiTorque are always seated tightly, because the seating thrust of valve disc is accurately maintained in each closing-cycle, due to the patented torque limiting mechanism.

LimiTorque is, by far, the most widely used valve operator in the World... Send for complete new Catalog L-550, on your Business Letterhead.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

For more data on advertised products, use Readers' Service Cards, last page.

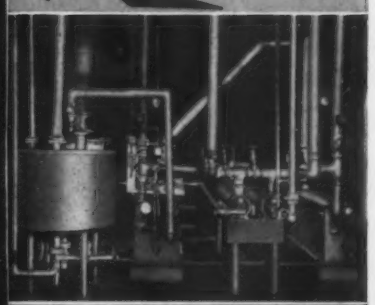
Continuous operating temperature up to 600° F.

Isn't this the kind of heat transfer system you want?

Pin-point control to within 2° F.

Lower cost, non-pressurized equipment

Safety from fire and explosion



... THEN YOU WANT A

non-pressurized Aroclor 1248 system

Aroclor 1248 is a new kind of heat transfer fluid that's fire-resistant ... operates at atmospheric pressure.

The Equipment ... capacities can range from small portable units—usually electrically heated—to large gas- or oil-fired units generating from 250,000 to over 10,000,000 B.T.U.'s per hour. Circuits are closed, forced circulation. Compact design saves space, minimizes installation and maintenance costs.

The Fluid ... Aroclor 1248 is a highly stable chlorinated polyphenyl; does not support combustion up to its boiling range 652° to 725° F.; has autogenous ignition temperature of extremely high 1299° F.; is noncorrosive; operates in most systems four to seven years without replacement.

Contact Monsanto for sources of Aroclor 1248 heating systems, information about Aroclor 1248 heat transfer fluid.

MONSANTO®

Where Creative Chemistry Works Wonders For You

Organic Chemicals Division
MONSANTO CHEMICAL COMPANY
Dept. IF-71, St. Louis 1, Missouri

For more data on advertised products, use Readers' Service Cards, last page.

NEW . . . PRE-ENGINEERED WHITLOCK Hi-Transfer EXCHANGERS

for petrochemical processing applications

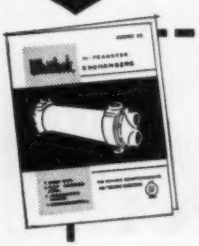
Wherever processing requirements call for small to medium size exchangers for cooling or heating, it will pay you to consider the advantages of Whitlock Standardized Hi-Transfer units. Now available from stock in a wide range of sizes, these dependable, easy-to-install exchangers are pre-designed to provide all the advantages of custom-made exchangers *without* their high cost or shipping delays. Here are just a few of their many advantages:

- **LOW COST.** Quantity produced according to standard details from stock materials.
- **ENGINEERED DESIGN** to promote high heat transfer with minimum pressure drop.
- **INTERCHANGEABLE PARTS** and units for rapid installation and servicing.
- **RUGGED, NON-FERROUS CONSTRUCTION.** All parts constructed of non-corrosive copper and copper alloys for long, trouble-free service.
- **SIMPLIFIED MAINTENANCE.** Removable bonnets and straight tubes for easy cleaning and inspection.

Experienced Whitlock Engineers will gladly recommend the right Hi-Transfer Exchanger for your particular requirements. Write for complete details.

The WHITLOCK Manufacturing Co.
75 South St., West Hartford 10, Conn.
New York • Boston • Chicago • Philadelphia
Detroit • Richmond
Authorized representatives in other principal cities.
In Canada: Darling Bros., Ltd., Montreal

Ask for this FREE Hi-Transfer Brochure



Bulletin 170 contains complete technical information, including unit diagrams, pressure tables and specification data.

Your name.....

Company.....

Address.....

.....

Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers

Quality Control on Job Site is important too

In the prefabricating of critical piping in our plant, radiographic inspection, ultrasonic testing and magnetic-particle examination are routine precautions. That they are available in the field is to be expected of Mitchell's distinguished service to power and processing plants. For full satisfaction and economy, next time ask us in.

W. K. MITCHELL & CO., INC.

Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

For more data on advertised products, use Readers' Service Cards, last page.

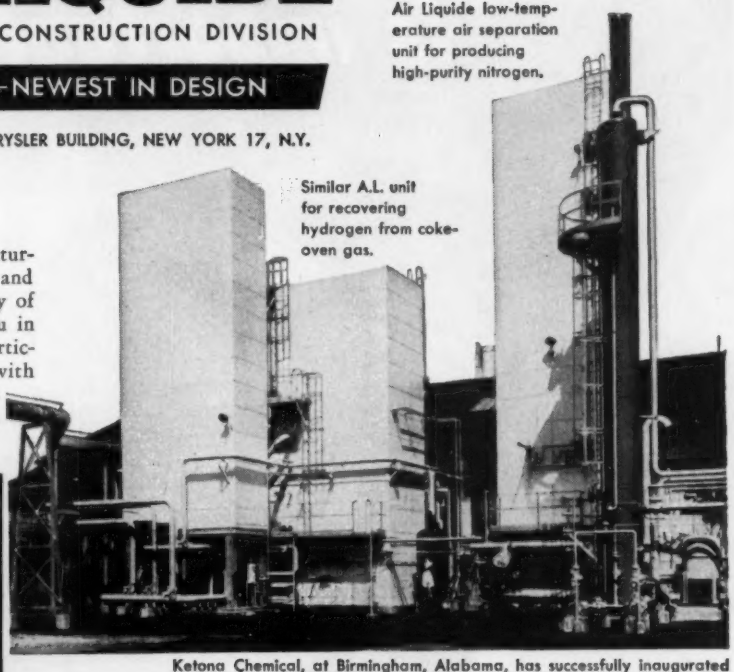
AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE — NEWEST IN DESIGN

529 CHRYSLER BUILDING, NEW YORK 17, N.Y.

In Canada: **L'Air Liquide**
1111 Beaver Hall Hill
Montreal, Que.

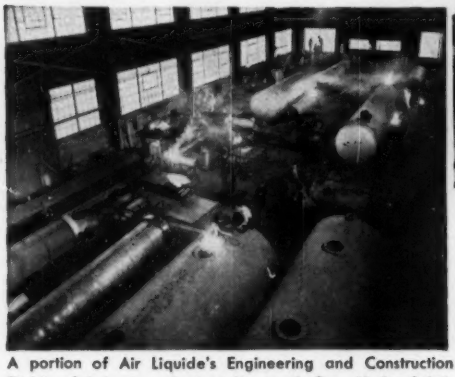
Our widely-experienced technical and manufacturing staff, including design, process, project and mechanical engineers, backed by half a century of "know-how," is at your service to assist you in applying low-temperature technology to your particular requirements. We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components "tailored" to your needs.



Air Liquide low-temperature air separation unit for producing high-purity nitrogen.

Similar A.L. unit for recovering hydrogen from coke-oven gas.

Ketona Chemical, at Birmingham, Alabama, has successfully inaugurated the first ammonia plant in this country designed exclusively around coke-oven gas as a source of hydrogen. The low-temperature gas separation units used at Ketona were designed and built by American Air Liquide.

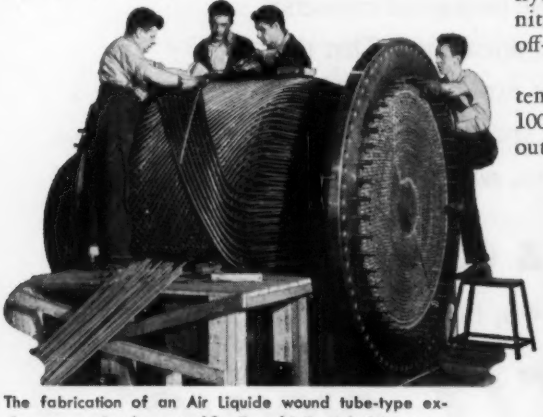


A portion of Air Liquide's Engineering and Construction Division fabricating plant at Montreal, Que. Under fabrication here are numerous all-welded stainless steel shells to house component exchangers, vaporizers, rectification columns, etc., of the liquefaction equipment.

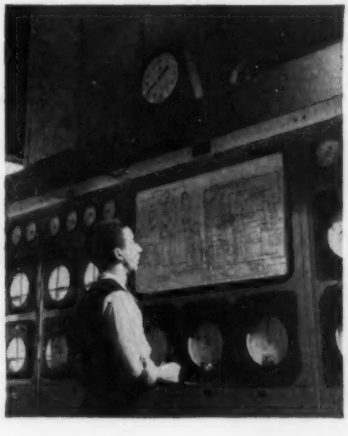
Low-temperature separation processes, for recovering atmospheric and hydrocarbon gases in tonnage quantities, are being used on a rapidly increasing scale in the United States.

Once confined to the separation of oxygen, nitrogen and the rare gases of the atmosphere, the low-temperature liquefaction process of separation is today successfully producing high-purity hydrogen, pure carbon monoxide, methane, ethylene, propane and nitrogen, from such gaseous mixtures as: natural gas, refinery off-gases and coke-oven gas.

During the past 50 years, Air Liquide (a pioneer in the low-temperature gas separation field) has designed and built more than 1000 hydrocarbon and air-separation plants for industries throughout the world. In the United States it is a leader in this field.



The fabrication of an Air Liquide wound tube-type exchanger can involve over 10 miles of intimately interwoven copper tubing to provide the necessary cooling surfaces in this specialized low-temperature equipment.



Centre of control panel for a large-tonnage oxygen plant includes a flow sheet for the operator's guidance. Once put "on stream", operation of Air Liquide low-temperature plants is almost entirely automatic.

L'Air Liquide, its affiliates and subsidiaries have offices and plants throughout the world: Algeria, Argentina, Belgium, Brazil, Cameroon, Canada, China, Egypt and Sudan, France, French Congo, French West Africa, Gold Coast, Great Britain, Greece, Indochina, Italy, Ivory Coast, Japan, Lebanon, Luxemburg, Madagascar, Malay States, Morocco, Netherlands, Paraguay, Portugal, Siam, South Africa, South-East Asia, Spain, Sweden, Syria, Tunisia, and the United States of America.

POTTERMETERS®

for any size line

Potter Electronic Flowmetering Systems represent the most modern concept in fluid flow measurement. The POTTERMETER Flow Sensing Element incorporates a hydraulically-positioned, bearingless rotor. Standard POTTERMETERS are available in stainless steel or other non-magnetic material, and can be mounted in any position with a variety of coupling designs.

Widely used in the chemical and process industries, POTTER Flow-metering Systems feature high accuracy throughout a wide range of temperature, pressure, density and viscosity conditions. Unparalleled for applications involving hydrocarbons, corrosive liquids, liquefied gases, gases and various forms of air flow measurement. POTTERMETERS can be supplied with indicating, recording and/or control apparatus, or may be utilized with existing instrumentation.

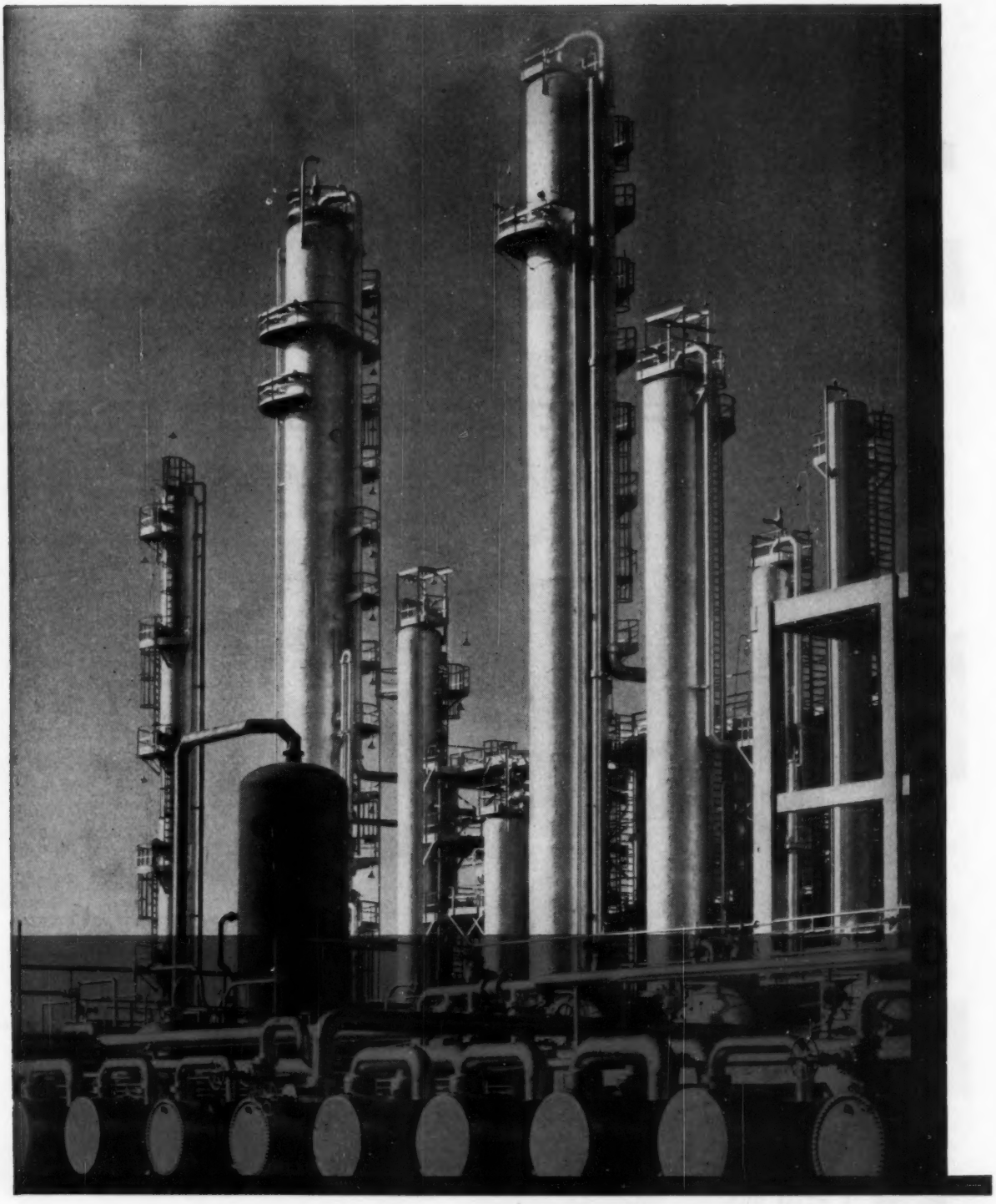
Write today for Bulletin PR-5

STANDARD POTTER EQUIPMENT HANDLES FROM ONE TO 30,000 AND MORE BARRELS OF OIL PER HOUR

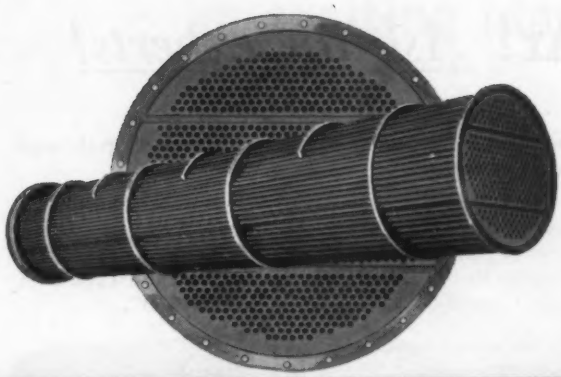
POTTER engineered

POTTER AERONAUTICAL CORP.
Industrial Division
U. S. Route #22, Union, New Jersey
MUrdock 6-3010

For more data on advertised products, use Readers' Service Cards, last page.



FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



For dependable "on-stream" performance...
retube your exchangers with

PHELPS DODGE HEAT EXCHANGER TUBES!

Wide selection of copper-base alloys for every type of application—including bi-metal combinations.

Complete warehouse stocks maintained at Houston, Texas; Tulsa, Okla.; Los Angeles, Cal.; Chicago, Ill.; and Bayway, N. J.

Expert assistance in solving your tube corrosion problems.

Specify Phelps Dodge... One of the largest suppliers of tubes to manufacturers of heat exchangers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

For more data on advertised products, use Readers' Service Cards, last page.

How to get the longest tube life per dollar! *Ask the experts!*

THE Timken Company offers 22 different high-temperature tube steels to solve your problems of heat, pressure, corrosion and oxidation. *One* of these tube steels has the analysis most suited to your needs, gives you maximum tube life per dollar of cost.

To find this analysis, *ask the experts!*—the metallurgists of The Timken Roller Bearing Company.

More than 20 years of experience has made Timken Company metallurgists recognized authorities on high-temperature steels. You put this backlog of experience to work for you when you consult these experts. They'll study your specific requirements, then recommend the one tube steel that fits them—most economically.

And you can be sure of uniform high quality in the Timken steel you get. One reason: we make our own fine alloy steels in electric furnaces. This enables us to maintain rigid quality control from melt shop through final inspection.

Timken Company metallurgists will be glad to help you solve your tube steel problems. When you *ask the experts,* you get longest tube life for your dollar. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

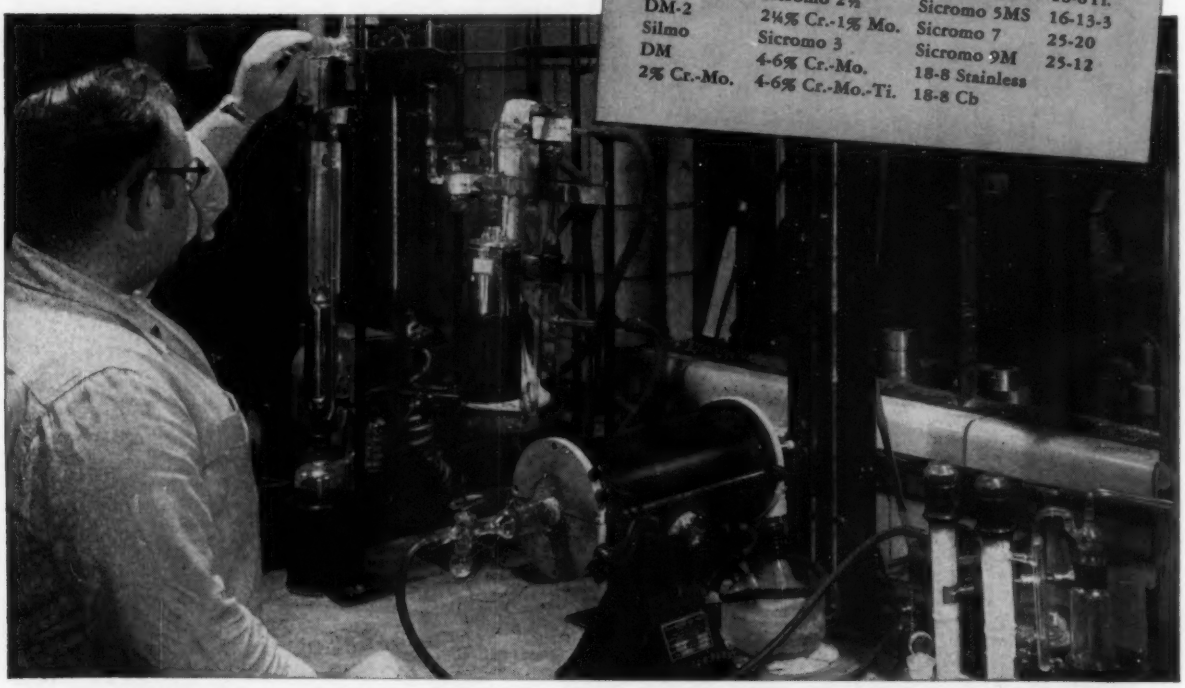
This month's report is on:

DM-2 STEEL

Suggested as a substitute for 0.50% Mo. steel. Has greater creep strength and somewhat better corrosion and oxidation resistance than 0.50% Mo. steel. For use in cracking furnace tubes, high pressure boiler tubing, superheater tubing and high temperature steam piping.

22 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	18-8Ti.
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-20
Silmo	Sicromo 3	Sicromo 9M	25-12
DM	4-6% Cr.-Mo.	18-8 Stainless	
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	



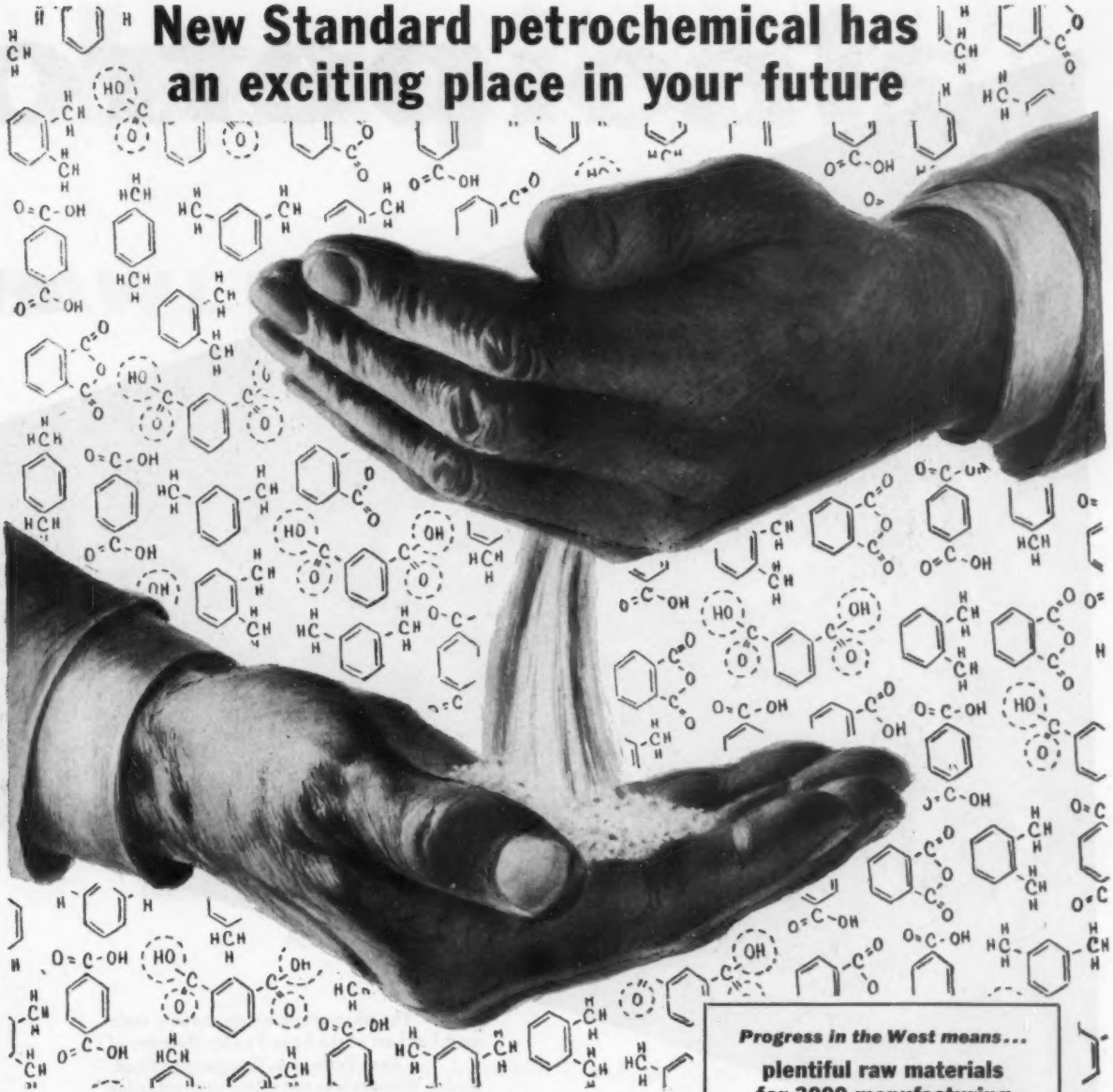
This chlorination equipment helps us determine cleanliness of our steel by purifying extracted non-metallic residues. It's one of many ways we make sure you get steel of uniform high quality.

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

New Standard petrochemical has an exciting place in your future



Hundreds of thousands of man hours in research produced these crystals that will revolutionize many paints and plastics.

HOUSE PAINTS THAT LAST YEARS LONGER, superstrong lightweight luggage, improved fibre-glass fishing rods and boats . . . these are some of the things that will come from Isophthalic*, a new petrochemical from Standard laboratories. Even though its possibilities have only begun to be explored, we have invested in a multi-million dollar plant to manufacture Isophthalic.

We're convinced it will make as important a change in your life as detergents, wrinkle-resistant fabrics and other modern wonders whose basic materials were products of Standard research.

Progress in the West means...

plentiful raw materials for 3000 manufacturing firms by 1965

Standard's economists say: "New products from Isophthalic will help provide employment for the 600,000 new workers in manufacturing the West will have by 1965."

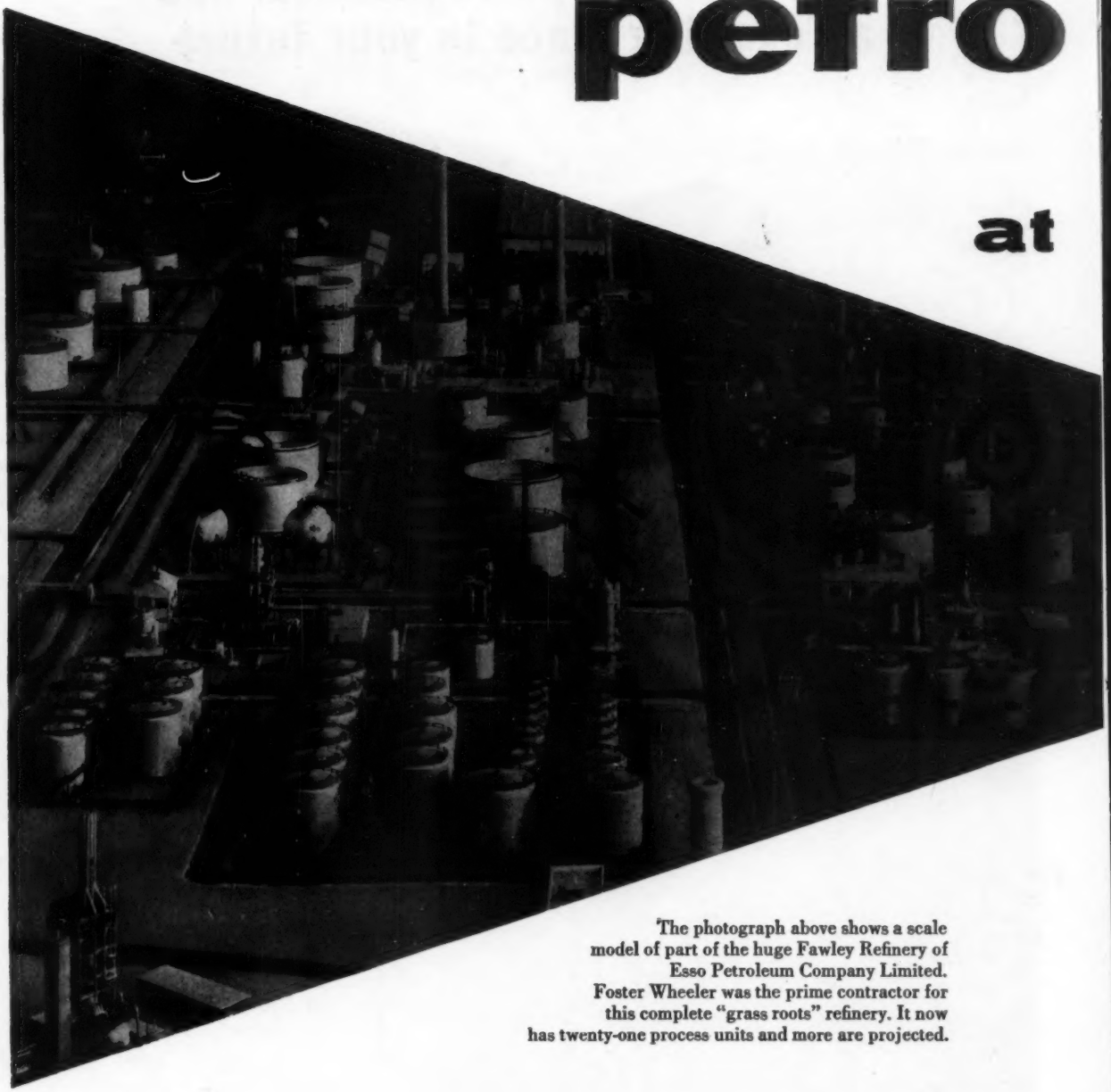
*Manufactured and distributed by Standard's wholly owned subsidiary, Oronite Chemical Company.

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better

petro

at



The photograph above shows a scale model of part of the huge Fawley Refinery of Esso Petroleum Company Limited. Foster Wheeler was the prime contractor for this complete "grass roots" refinery. It now has twenty-one process units and more are projected.

• FOSTER WHEELER DESIGNS AND BUILDS

PETROLEUM, CHEMICAL AND PETROCHEMICAL PROCESSING PLANTS

ANYWHERE IN THE WORLD

FW FOSTER

NEW YORK • LONDON

chemicals

FAWLEY

NEW PETROCHEMICAL PLANT for England's Largest Refinery, will be designed and built by Foster Wheeler

SYNTHETIC rubber and plastic hydrocarbon raw materials (ethylene, propylene, butylene and butadiene) will be produced from 250,000 tons per year of petroleum intermediates in a major process installation at the Fawley, England, refinery of Esso Petroleum Company Limited. Foster Wheeler, who built the new Fawley petroleum refinery, the largest in England, will also provide mechanical design and construction for this petrochemical project. Esso Research and Engineering Company supplied basic process design data.

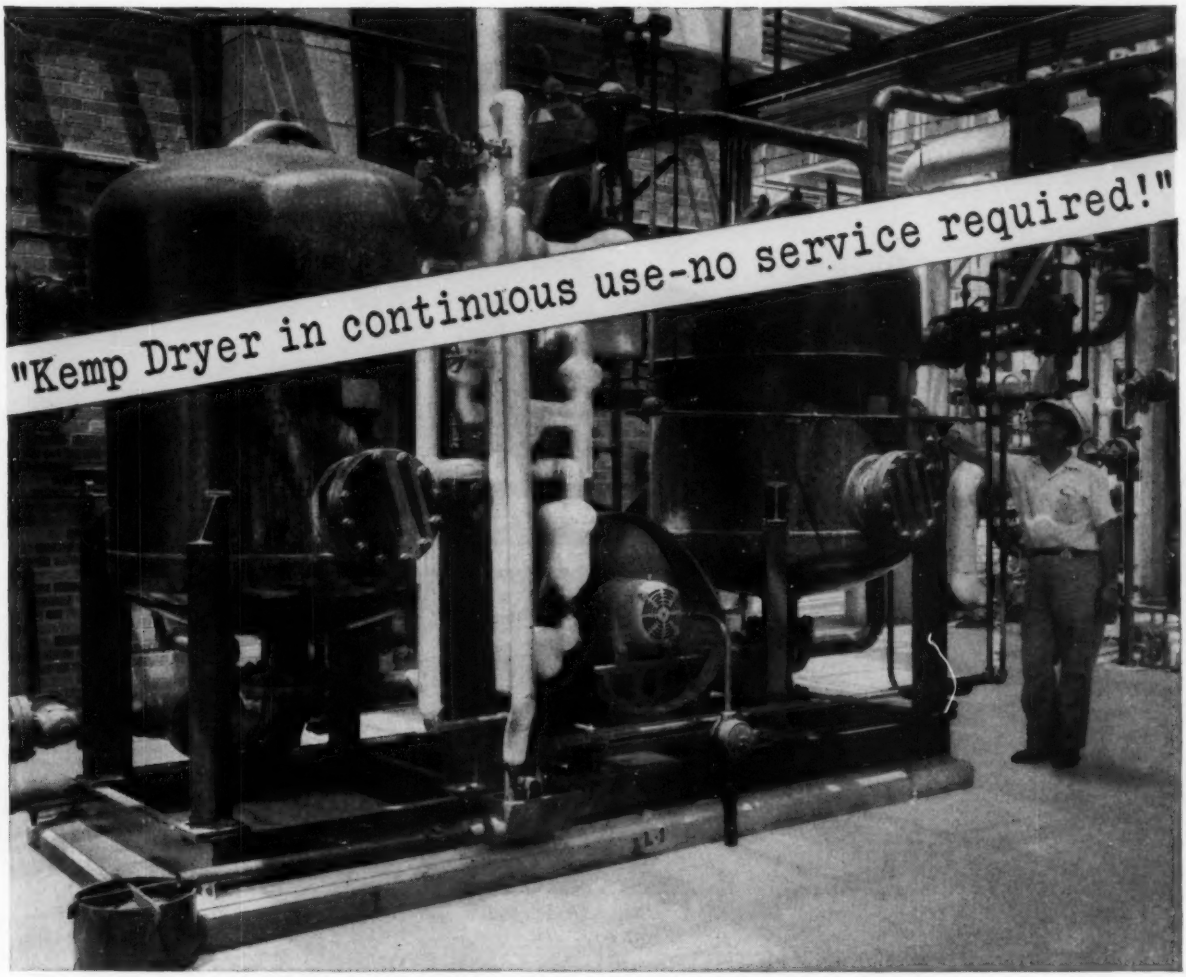
These basic hydrocarbon products represent a new and very substantial source of raw material for the British synthetic rubber and plastic industries.

Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

WHEELER

PARIS • ST. CATHARINES, ONT.

For more data on advertised products, use Readers' Service Cards, last page.



Cities Service Petroleum reports:

Kemp Dryer in continuous operation 7 days a week; has required no service or downtime!

To dry compressed air for instruments in a hydroformer unit at its refinery in Lake Charles, Louisiana, Cities Service Refining Corporation has installed a Kemp Model LC SE2 Air Dryer. Since January, 1955, it has served continuously—seven days a week—drying 1900 cubic feet of air per minute to a dew point of −10° F.

This fully automatic Kemp Dryer, reactivated every 12 hours (or 22,800 cubic feet of air), has so far required no downtime or service at all! And, according to Mr. Glendon L. Smith, Unit Engineer at Cities Service, there is practically no pressure drop from the entering pressure of 285 pounds . . . further indication of Kemp quality and efficiency.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases or liquids, contact Kemp now. For complete facts and technical information, write for Bulletin No. D-100.

KEMP OF BALTIMORE

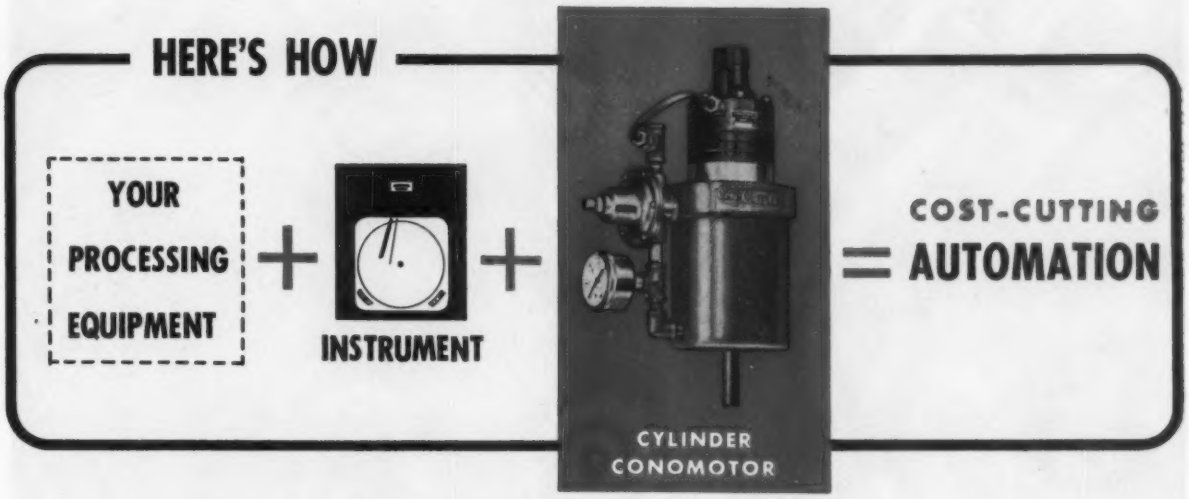
DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

CONOFLOW *Shows You the Way to* AUTOMATION

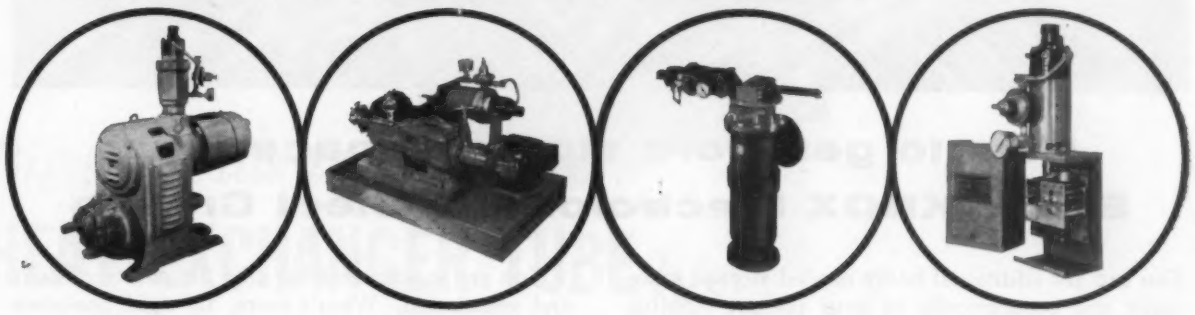
HERE'S HOW



The Conoflow Cylinder Conomotor—a powerful pneumatic actuator—has accelerated industry's approach to the automatic factory and the continuous process plant. A wide range of final control elements, never before available, has been created by the Cylinder Conomotor, a servo capable of following the exact signal outputs of modern electronic and pneumatic instruments.

Cylinder Conomoters, acclaimed by industry as the ultimate in control valve actuators, are fast becoming the standard for automatic control of other process regulating equipment. A few of these are: motor driven speed changers, proportioning pumps, flow regulators, electric timing devices, and numerous electrical systems components such as rheostats, autotransformers and potentiometers.

A FEW EXAMPLES OF CONOFLOW AUTOMATION . . .



U.S. Electrical Motors
Variable Speed Drive

Proportioneers
Proportioning Pump

Kates
Flow Regulator

Dorr-Oliver
Electric Timer

Conoflow application engineers, well versed in systems engineering methods, will gladly help you evaluate the use of the Cylinder Conomotor on your equipment. Avail yourself of the tremendous advantages offered by this concept of automation, including increased productivity . . . savings in man power . . . improved quality control . . . and many other benefits. Call or write today for "personalized" service. Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. Representatives in principal cities.

WRITE FOR BULLETINS B-50-2-A AND EB-2-A

CC-700

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

SUBSIDIARY OF WALWORTH

How to get more storage space with BLAW-KNOX Electroforged® Steel Grating

You can get additional badly needed storage space easily and economically in your present building simply by installing platforms of Blaw-Knox Grating. It fits easily, neatly around pipes, beams and machinery without any alterations to your building.

Maintenance costs are slashed into the bargain. There's nothing to wear, nothing to patch. Blaw-Knox grating is self cleaning too. No sharp corners to clog up with dirt, and you'll find painting is easy since all surfaces are easily accessible.

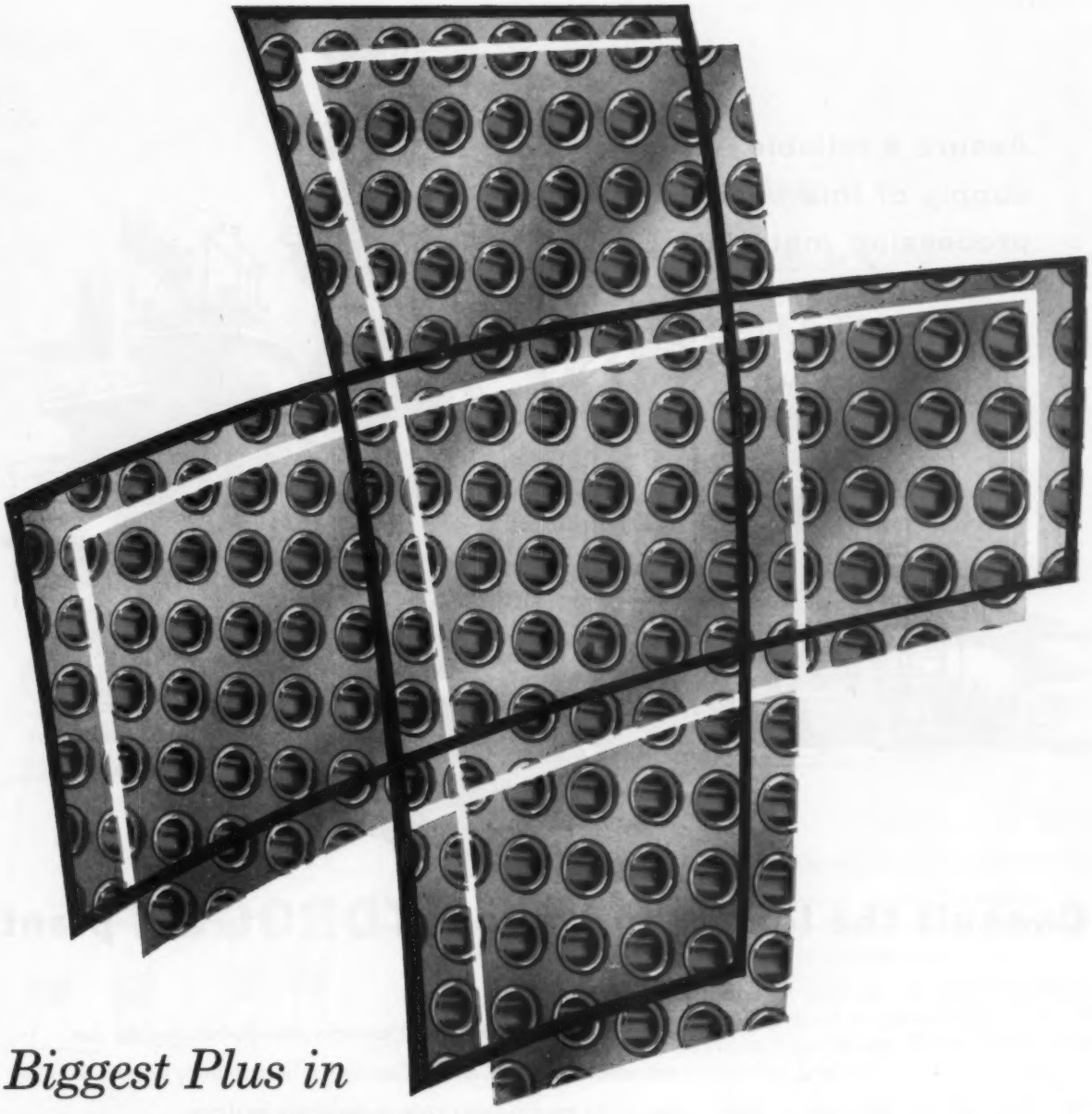
You get maximum open area for plenty of light and ventilation. What's more, its rigid one-piece construction means maximum structural strength and load bearing capacity.

Blaw-Knox Electroforged Grating for walkways, stair treads and floors is fabricated to your specifications to meet your own operating requirements. Complete data on all types is contained in Bulletin 2527. Write for your copy today.

BLAW-KNOX

BLAW-KNOX COMPANY

Blaw-Knox Equipment Division
Dept. D, Pittsburgh 38, Pa.



Biggest Plus in

HEAT EXCHANGER TUBE *life...*

CHASE® *dependability!*

Dependability is more than just a word with Chase. It's a reality! Or, rather, one hundred and twenty million pounds of reality. That's roughly how much Chase Antimonial Admiralty has been put into service since 1935—without a single reported dezincification failure! What does it mean? Simply this: superior corrosion resistance under adverse conditions...far fewer equipment breakdowns...extra years of money-saving service. Each a profitable plus! See! Today write for your free 54-page manual: *"Chase Condenser and Heat Exchanger Tubes."*

Chase®

BRASS & COPPER CO.

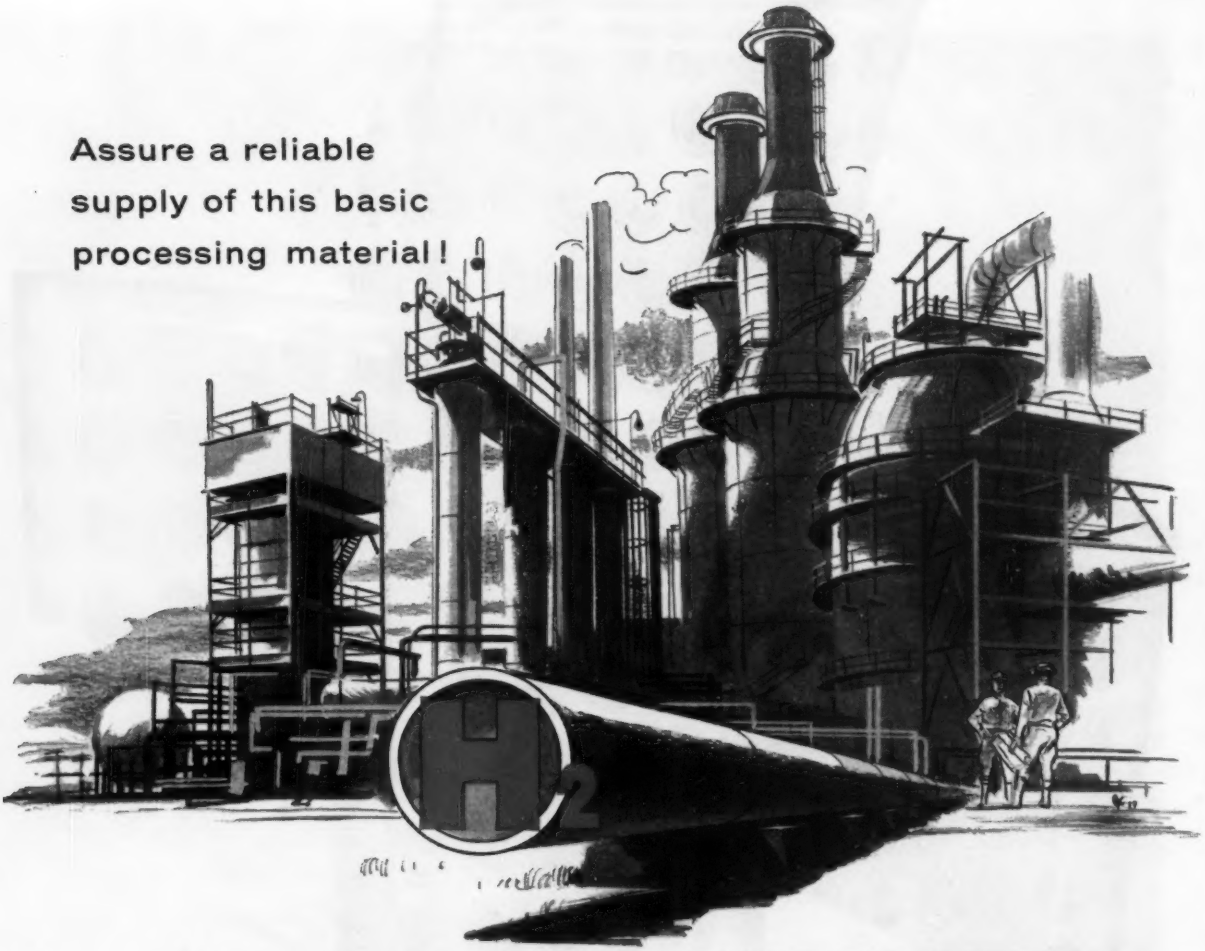
WATERBURY 20, CONNECTICUT

SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta	Cleveland	Indianapolis	New Orleans	Rochester
Baltimore	Dallas	Kansas City, Mo.	New York (Maspeth, L.I.)	St. Louis
Boston	Denver	Los Angeles	Philadelphia	San Francisco
Charlotte	Detroit	Milwaukee	Pittsburgh	Seattle
Chicago	Grand Rapids	Minneapolis	Providence	Waterbury
Cincinnati	Houston	Newark		

For more data on advertised products, use Readers' Service Cards, last page.



Consult the leader for your HYDROGEN plant

Most of the hydrogen plant capacity installed during the last ten years in the U.S.A. and Canada has been built by Girdler. So . . . to get top experience in hydrogen facilities . . . to assure utmost reliability of supply of this basic process material . . . call in Girdler when you start to plan.

There is a Girdler hydrogen plant for every need . . . any capacity . . . any hydrogen purity. Call or write for complete information.

the GIRDLER Company A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION . . . Design, Engineering, Construction of Hydrocarbon Processing Plants, Gas Plants, Chemical Plants. Offices: New York, San Francisco
In Canada: Girdler Corporation of Canada, Ltd., Toronto, Ontario

"Personally,
I always specify
LEWIN-MATHES
Condenser Tube"

Lewin-Mathes welcomes stiff-necked specifications.

We meet them... because, as COPPER REFINERS, we control the exact composition of every alloy billet we form into condenser tube.

We meet them . . . because, as FABRICATORS, we control every step in the manufacture of Lewin-Mathes Condenser Tube from *raw material to finished product.*

We meet them . . . because, as INTEGRATED SPECIALISTS, we take pride in delivering every foot of Lewin-Mathes Condenser Tube uniform and perfect . . . "tailor-made" to perform better under *your* specific operating conditions.

Lewin-Mathes' mastery over every physical and chemical property of Heat Exchanger Tube can mean important savings for you. Bring your condenser tubing problems to us and see!

Nothing primitive about Lewin-Mathes service facilities. Expert technical and engineering assistance is available to you through 25 strategically-located Branch Offices.

LEWIN MATHES
SAINT LOUIS, MISSOURI
COPPER CUPRO-NICKEL AND BRASS CONDENSER TUBE, PIPE AND ROD

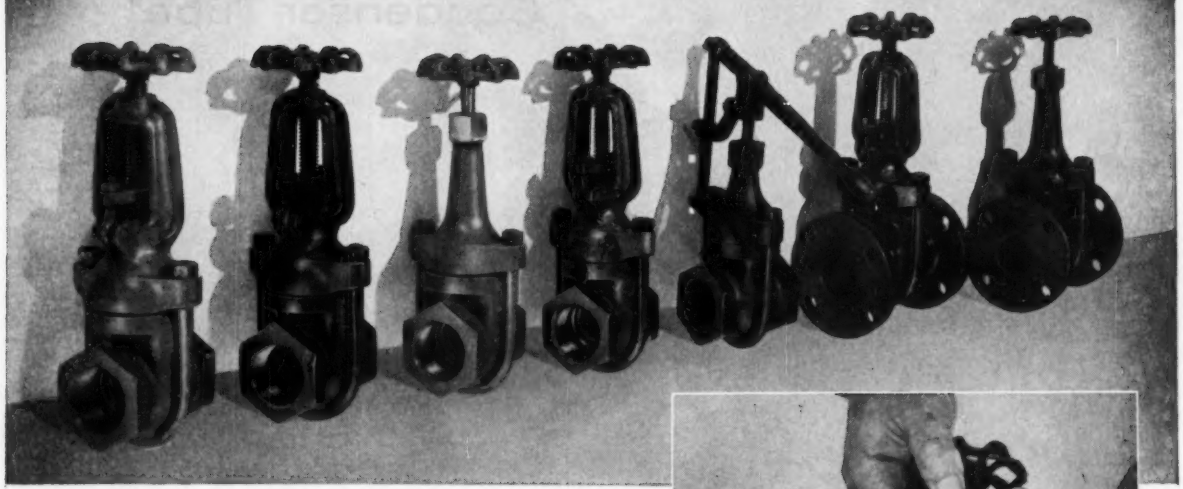
For more data on advertised products, use Readers' Service Cards, last page.

Eleven lines of WALWORTH Saddle Type Wedge Gate Valves

Bronze-Mounted — All-Iron — Ni-Resist

Outside Screw and Yoke — Non-Rising Stem — Quick Opening

Flanged Ends — Screwed Ends



Walworth saddle-type wedge gate valves are manufactured in eleven different combinations of designs and materials, seven of which are illustrated above.

Saddle type wedge gate valves are easy to take apart and are particularly suitable for lines requiring frequent cleaning. Walworth Saddle-Type Wedge Gate Valves are available in a variety of designs including OS & Y; Inside Screw Rising Stem, and Sliding Stem Quick Opening types—in Bronze-Mounted, All-Iron, and Ni-Resist. All types are designed to permit repacking under pressure in either the open or closed position.

FOR COMPLETE INFORMATION, See your local Walworth Distributor or write on business stationery for illustrated circular.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH

60 East 42nd Street, New York 17, New York

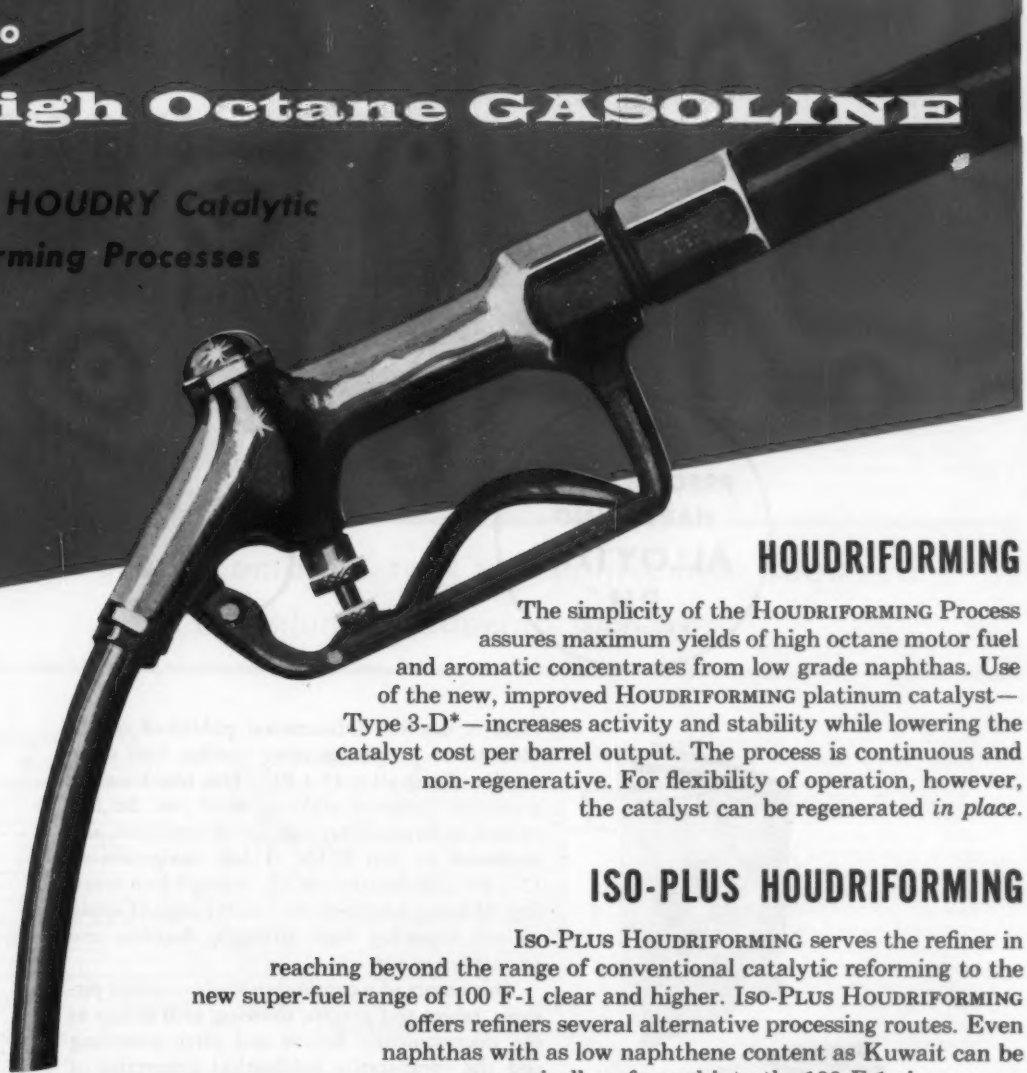
SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION GROVE VALVE & REGULATOR CO. SW SOUTHWEST FABRICATING & WELDING CO., INC. MH M & H VALVE & FITTINGS CO. WALWORTH COMPANY OF CANADA, LTD.

Low Grade NAPHTHAS

to

High Octane GASOLINE

with HOUDRY Catalytic Reforming Processes



HOUDRIFORMING

The simplicity of the HOUDRIFORMING Process assures maximum yields of high octane motor fuel and aromatic concentrates from low grade naphthas. Use of the new, improved HOUDRIFORMING platinum catalyst—Type 3-D*—increases activity and stability while lowering the catalyst cost per barrel output. The process is continuous and non-regenerative. For flexibility of operation, however, the catalyst can be regenerated *in place*.

ISO-PLUS HOUDRIFORMING

ISO-PLUS HOUDRIFORMING serves the refiner in reaching beyond the range of conventional catalytic reforming to the new super-fuel range of 100 F-1 clear and higher. ISO-PLUS HOUDRIFORMING offers refiners several alternative processing routes. Even naphthas with as low naphthene content as Kuwait can be economically reformed into the 100 F-1 clear range.

WRITE TODAY FOR INFORMATION ON HOUDRY PROCESSES, SERVICES OR CATALYSTS.

***TYPE 3-D PLATINUM CATALYST**

This new, improved HOUDRY catalyst gives increased activity, is highly selective, and possesses proven, long-term stability. You'll want to investigate the process economies of Type 3-D and other HOUDRY catalysts.

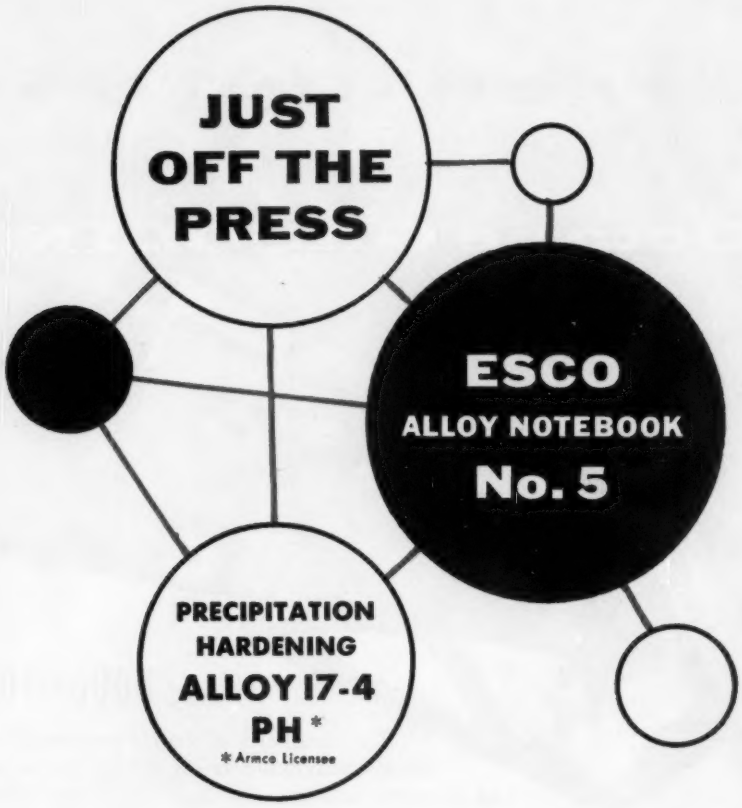
HOUDRY

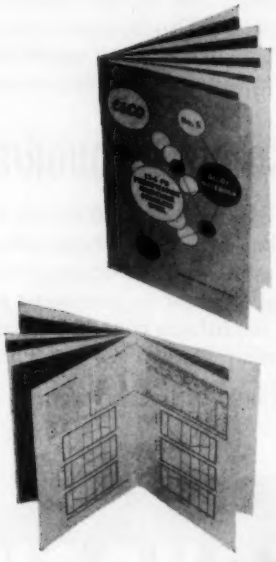
PROCESS CORPORATION

1528 Walnut St., Philadelphia 2, Pa.

PIONEER IN CATALYTIC PROCESSES

For more data on advertised products, use Readers' Service Cards, last page.





Here is the first information published on the mechanical properties after various heat treatments, of cast alloy 17-4 PH. This true heat and corrosion resistant stainless steel can be machined, in its relatively soft as-cast condition, and hardened to 400 BHN at low temperatures. 17-4 PH also has the ability, through heat treating, of being adaptable to a wide range of applications requiring high strength, ductility and impact resistance.

This report of a continuing study contains pictures, tables and graphs, showing such things as the microstructure before and after annealing and the comparative mechanical properties of 17-4 PH.

Industry as diversified as aircraft parts, food processing equipment and chemical pump manufacturers are among the enthusiastic users of Alloy 17-4 PH.

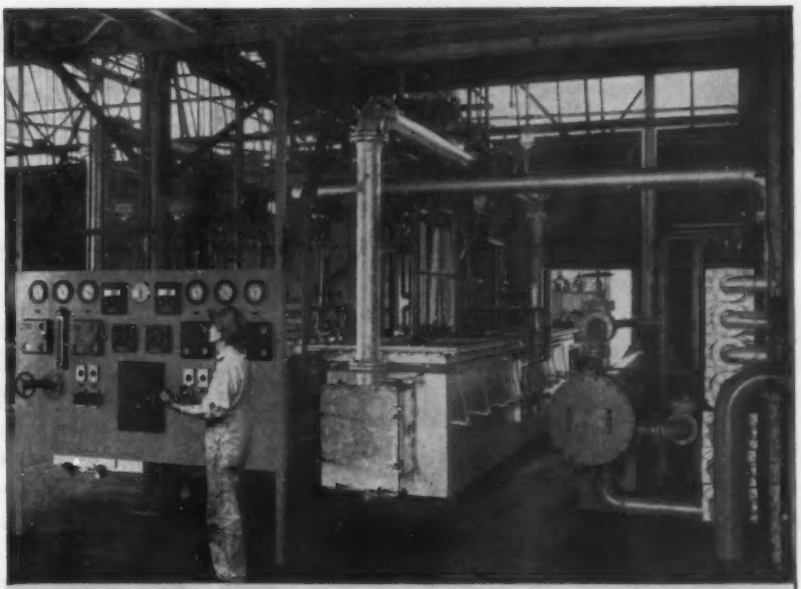
Write for your free copy today.

ESCO®

ELECTRIC STEEL FOUNDRY COMPANY

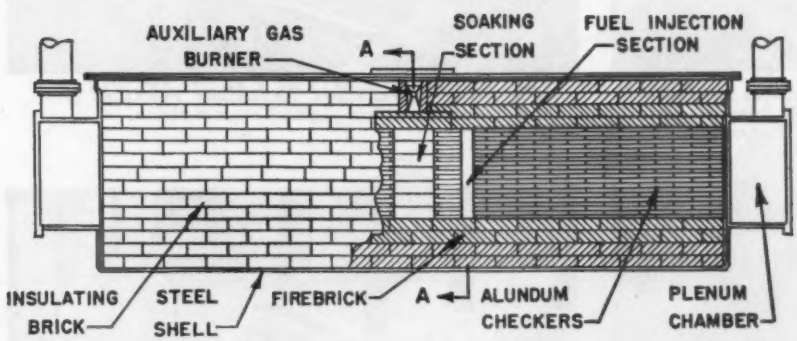
2164 N. W. 25TH AVE. • PORTLAND 10, OREGON
MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.
Offices in Most Principal Cities
ESCO INTERNATIONAL, NEW YORK, N. Y.
IN CANADA ESCO LIMITED

ALUNDUM* checkers give 4 years continuous service

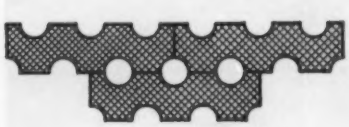


In this double regenerative furnace the Wulff Process Company of Huntington Park, Calif., produces acetylene starting with propane or other petroleum gas as the raw material. The Wulff Company reports that ALUNDUM checkers in this equipment are still going strong after continuous service, five days a week for more than four years.

Wulff Process Company says no replacement required in acetylene producing furnaces



Cross sectional diagram shows, in yellow, the location of Norton ALUNDUM checkers in the Wulff furnace. Air, preheated in the first ALUNDUM regenerator to 1800° F., is mixed with gas in the fuel injection section producing high temperatures and transferring this heat to the second regenerator. A propane-steam mixture is then passed in the opposite direction through the regenerators, heating and cracking in the second and cooling in the first. The heating and cracking cycles are both of one minute duration. ALUNDUM checkers take this extreme cyclic thermal stress and provide efficient, low cost operation.



Tubular passages for preheated flow are formed by ALUNDUM checkers. Their resistance to the erosion of hot gases is extremely important in many installations. Also, their purity is essential. Iron or other impurities could result in harmful side reactions in such gas cracking operations.

Norton refractories, engineered and prescribed for better performance in many types of equipment, provide long life, exceptional hot strength and maximum protection against the mechanical and chemical attacks of a wide variety of fuels. For further facts on these advantages write to NORTON COMPANY, Refractories Division, 464 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed
Making better products... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING DIVISION PRODUCTS: Coated Abrasives • Sharpening Stones • Behr-cat Tapes

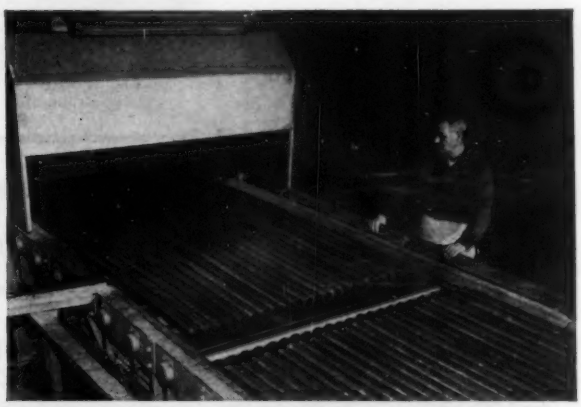
For more data on advertised products, use Readers' Service Cards, last page.

Here's why you get that extra measure of performance from **BRIDGEPORT** heat exchanger tubes

1 ELECTRONIC SPECTOGRAPH analyzes the composition of alloys from which condenser and heat exchanger tubes are made. From the very beginning, product performance and customer satisfaction are essential. Maintaining high metallurgical standards means high tube quality—it starts here.

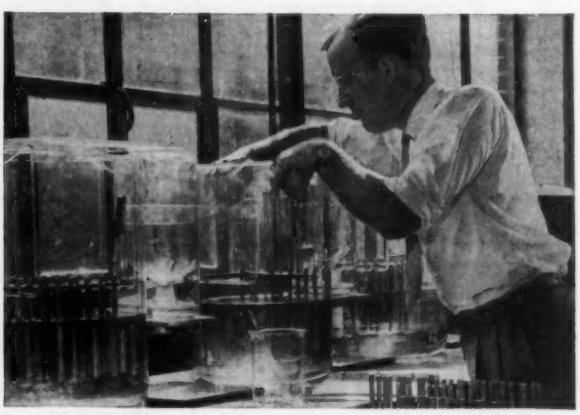
From spectograph to shipping, every step of Bridgeport Heat Exchanger Tube manufacture is carefully and closely controlled. Research, experience, skill and attention to your individual needs are integral qualities of every Bridgeport Heat Exchanger Tube that pay off in performance. Put them to work for you by calling your local Bridgeport Sales Office.

2 MODERN DRAW BENCH (its size speaks for itself) and others of the same "caliber" bring copper, alloy condenser and heat exchanger tubes down to exact, uniform dimensions.



3 HIGH-TEMPERATURE ANNEALING FURNACES give tubes the proper physical characteristics.

4 CLOSE INSPECTION of diameter, wall thickness and surface finish is made—another step that assures you that your Bridgeport tubes are made to flawless standards.



5 CORROSION RESEARCH is continuous at Bridgeport Corrosion Laboratories. Here the many alloys used under all corrosive conditions are tested; new alloys are developed from the knowledge and experience acquired here and in the field.

BRIDGEPORT CONDENSER & HEAT EXCHANGER TUBES

Bridgeport Brass Company • Bridgeport 2, Conn. • Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal

Efficient new pipe covering for outdoor or indoor lines operating up to 1800° F.

Kaylo-20*, a new, highly efficient pipe insulation for service at all temperatures to 1800° F., is made to fit pipes as large as 39″ in diameter. High flexural strength (50 lbs/in²) and compressive strength (100 lbs/in² at 5% deformation) plus light density (12 lbs/ft³) reduce breakage during installation and service, allow easy fabrication. Kaylo-20 is moisture resistant and dimensionally stable, keeps its high strength and efficiency with negligible shrinkage and warpage even under severe service conditions. Outdoors, weatherproof finishes are easily applied. Kaylo-20 is made to simplified dimensional standards, in 3′ lengths, 1″ to 3″ thicknesses.

Kaylo-20 is one of the many quality products in the full line of Armstrong Industrial Insulations. Armstrong also offers you a complete contracting service, geared to install these products economically and efficiently.

For full data on Kaylo-20 or any other Armstrong insulations, send for free booklets. Check the ones you want on the coupon below.

* T.M. Owens-Illinois Glass Co.

Armstrong
INDUSTRIAL INSULATIONS

☐ Kaylo-20 Insulating Block (data sheet)

☐ Kaylo-20 Pipe Covering (data sheet)

☐ Armstrong Armaglas** Insulations for Piping, Tanks, and Vessels

☐ Armstrong Armatemp† Insulating Cements

Armstrong Cork Company
2305 Ream Ave.
Lancaster, Penna.

Please send me the free booklets checked. ☐

Please have an Armstrong representative call. ☐

Name .....

Position .....

Company .....

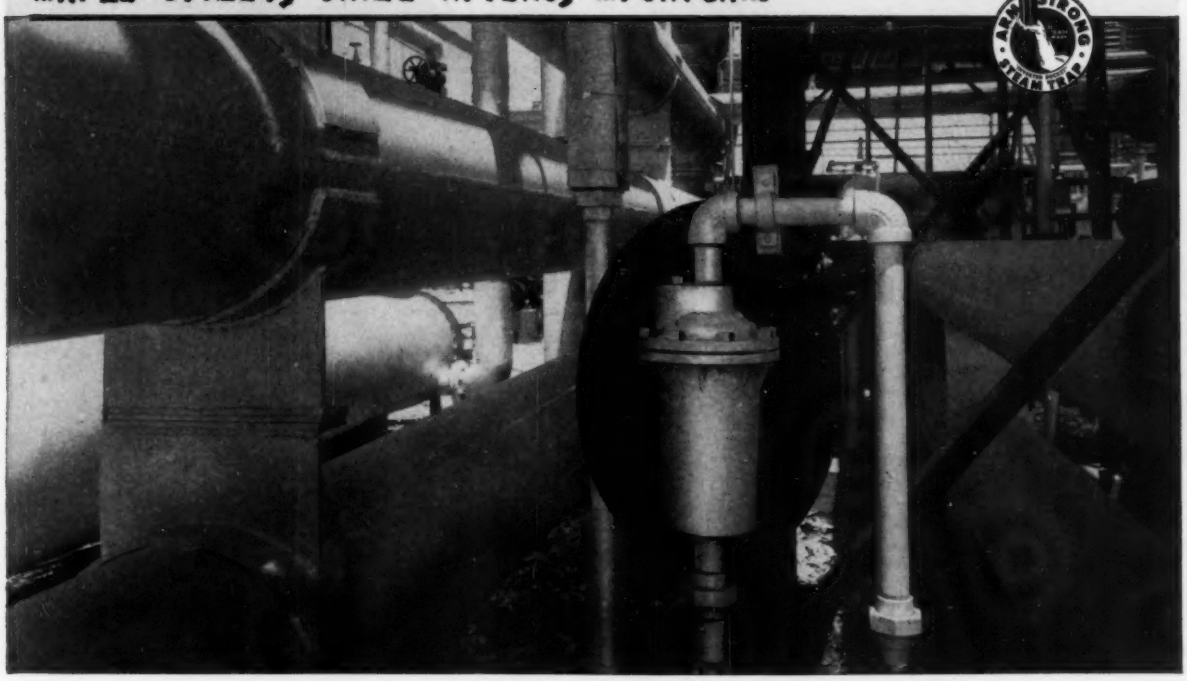
Address .....

City ..... Zone .... State .....

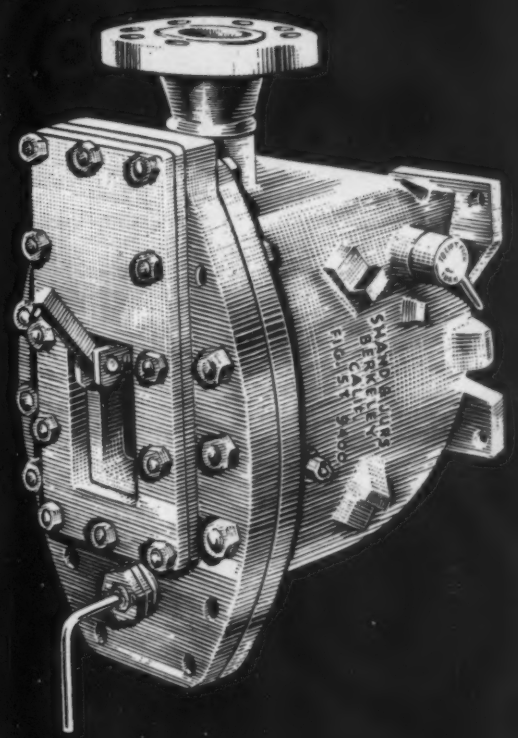
** T.M. Armstrong Cork Co. Manufactured by Owens-Corning Fiberglas Corp.
† Trade-Mark

For more data on advertised products, use Readers' Service Cards, last page.

BILLIONS OF BARRELS OF THROUGHPUT DEPEND ON ARMSTRONG STEAM TRAPS. THEIR OUTSTANDING RECORD FOR DEPENDABILITY AND LOW MAINTENANCE HAVE MADE THEM NO. 1 IN THE PETROLEUM INDUSTRY, WHERE THE BEST IS NONE TOO GOOD. TRAPS REPESENT A VERY SMALL FRACTION OF 1 PERCENT OF REFINERY CAPITAL INVESTMENT, YET VITALLY AFFECT EFFICIENCY AND MAINTENANCE COSTS. THIS IS NO PLACE TO PINCH PENNIES OR COMPROMISE ON QUALITY. CALL YOUR LOCAL ARMSTRONG REPRESENTATIVE... ASK FOR CATALOG J... OR WRITE ARMSTRONG MACHINE WORKS, 8523 MAPLE STREET, THREE RIVERS, MICHIGAN.



GREATER ACCURACY
in High Pressure Gaging of Storage Tanks



A NEW automatic tank gage for measuring product under pressures of from 150 to 300 pounds has just been released by S.&J. engineers, and brings new accuracy and safety to gaging tanks in which hand gaging is impossible and gage glasses are often inaccurate.

The new design incorporates a constant torque spring (Neg'ator Motor) which is an elastic member exerting a restraining force which does not increase as it is extended, giving consistent tape readings regardless of the position of the float. In addition to providing new accuracy over the entire range of float travel, this design also eliminates the conventional counterweight with its supporting tape and housing.

This new high pressure automatic gage, identified as Fig. ST-9400 is available for both ground and roof reading. The gage includes an 18-8 stainless steel tape graduated to eighths of an inch and a tubular aluminum pressure type float as standard, with stainless steel float optional. Engineers interested in the ultimate in high pressure gaging are invited to request complete details, drawings and prices.

SHAND AND JURS CO.

A SUBSIDIARY OF GPE

BERKELEY 10, CALIFORNIA

NEW YORK
110 E. 42nd St.

HOUSTON
M & M Bldg.

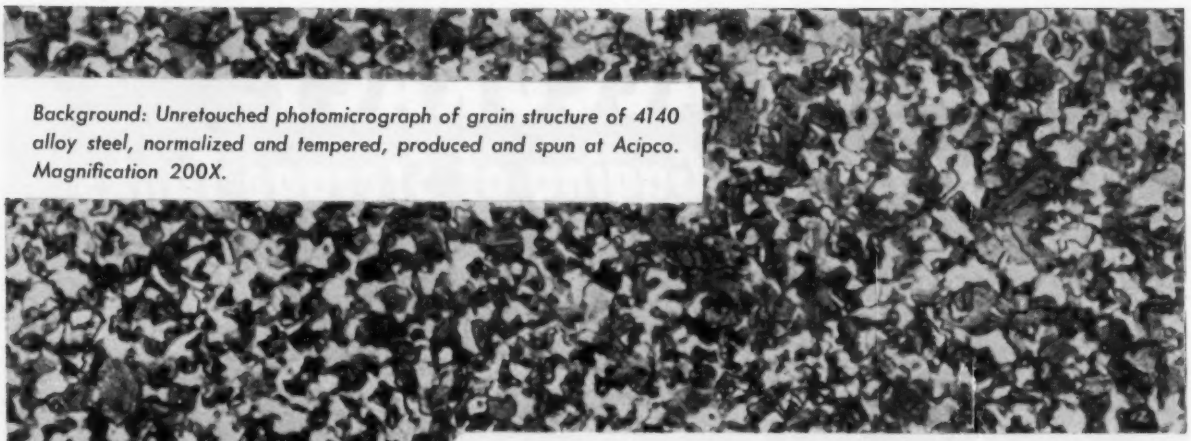
TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:
SEATTLE: Nebor Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W.
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglinton East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CALGARY: P. D. McLaren & Son, Ltd., 510 - 9th Ave. W.
MEXICO, D.F.: Dalmo Comercial, S. A.
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

For more data on advertised products, use Readers' Service Cards, last page.



Background: Unretouched photomicrograph of grain structure of 4140 alloy steel, normalized and tempered, produced and spun at Acipco. Magnification 200X.

A Better Pattern For Your Designs...

ACIPCO

Centrifugally Spun STEEL TUBES

This photomicrograph of the grain structure of the Acipco steel tube shows why parts made from these quality tubes are both easier to make and more economical to use.

Because it is centrifugally spun, the Acipco steel tube grain structure is more even, more dense, and more free from inclusions. This non-directional granular pattern means easier machining, greater strength, and greater durability in any design.

Non-directional grain structure is only one of the advantages you get when you specify and use Acipco Steel Tubes. If you manufacture or design products requiring tubular steel, write or call for full information about Acipco steel tube applications in your field.

SIZE RANGE: Lengths up to 16′ — longer lengths by welding tubes together. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels; plain carbon grades and special non-standard analyses.

FURNISHED: As cast, rough machined, or finish machined, including honing.

DISTRIBUTORS

Austin-Hastings Co., Inc.
226 Binney St.
Cambridge 42, Mass.

Peter A. Frasse and Co., Inc.
17 Grand St.
New York 13, N. Y.

Lyman Tube & Bearings, Ltd.
920 Ste. Sophie Lane
Montreal 3, Canada

Vinson Steel & Aluminum Co.
4606 Singleton Blvd.
Dallas 7, Texas

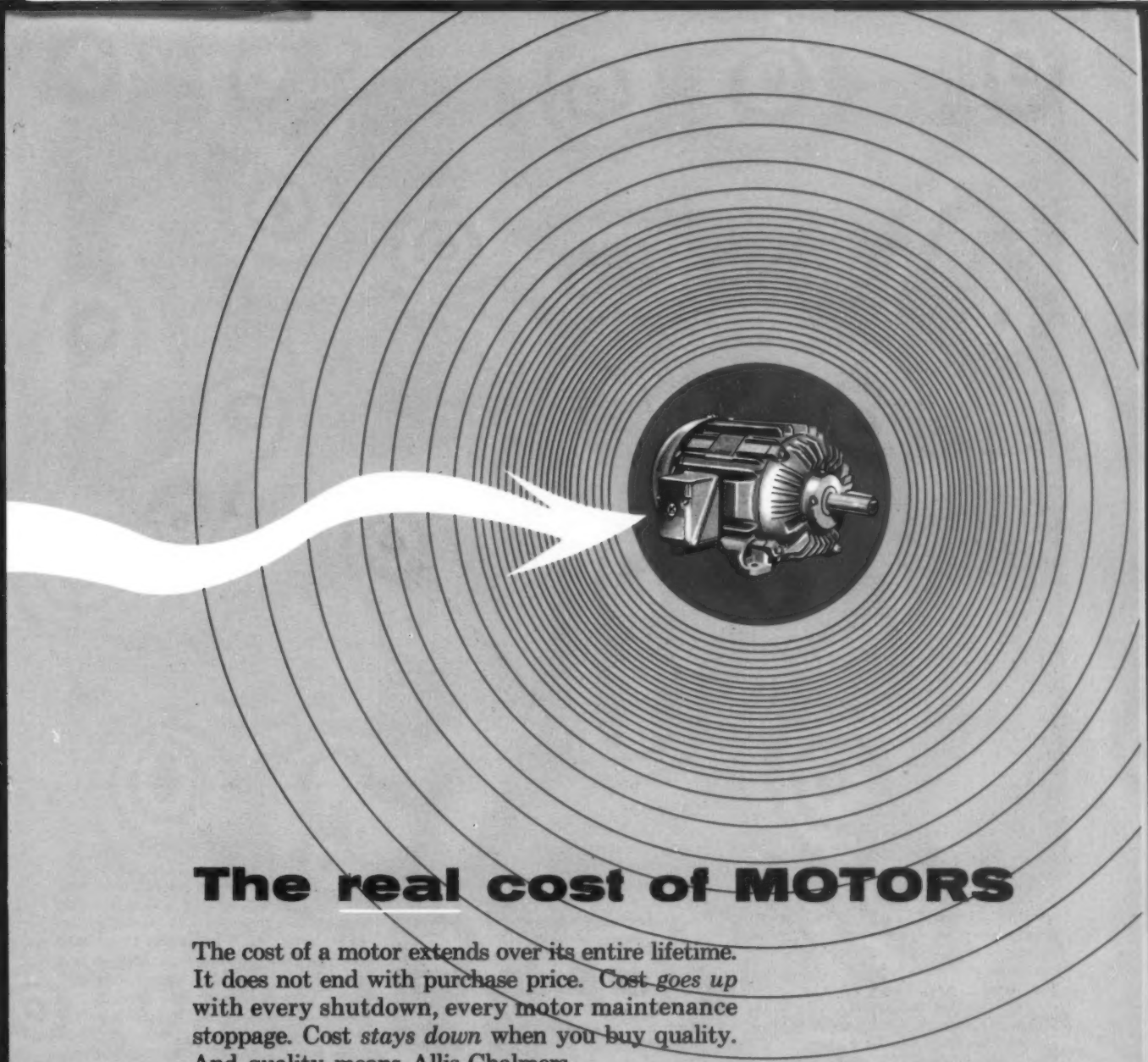
J. M. Tull Metal & Supply Co.
285 Marietta St., N. W.
Atlanta, Ga.

C. A. Roberts Company
2401 Twenty-fifth Avenue
Franklin Park, Ill.

Strong, Carlisle & Hammond Co.
1392 W. Third St.
Cleveland 13, Ohio

Ducommun Metals & Supply Co.
4890 So. Alameda St.
Los Angeles 54, Calif.

AMERICAN CAST IRON PIPE CO.
ACIPCO
Special Products Division
BIRMINGHAM 2, ALABAMA



The real cost of MOTORS

The cost of a motor extends over its entire lifetime. It does not end with purchase price. Cost *goes up* with every shutdown, every motor maintenance stoppage. Cost *stays down* when you buy quality. And quality means Allis-Chalmers.

All of these extras that don't show on the Allis-Chalmers nameplate — more copper, more iron, more cooling provisions—exemplify the quality-craftsmanship that goes in before the price tag goes on.

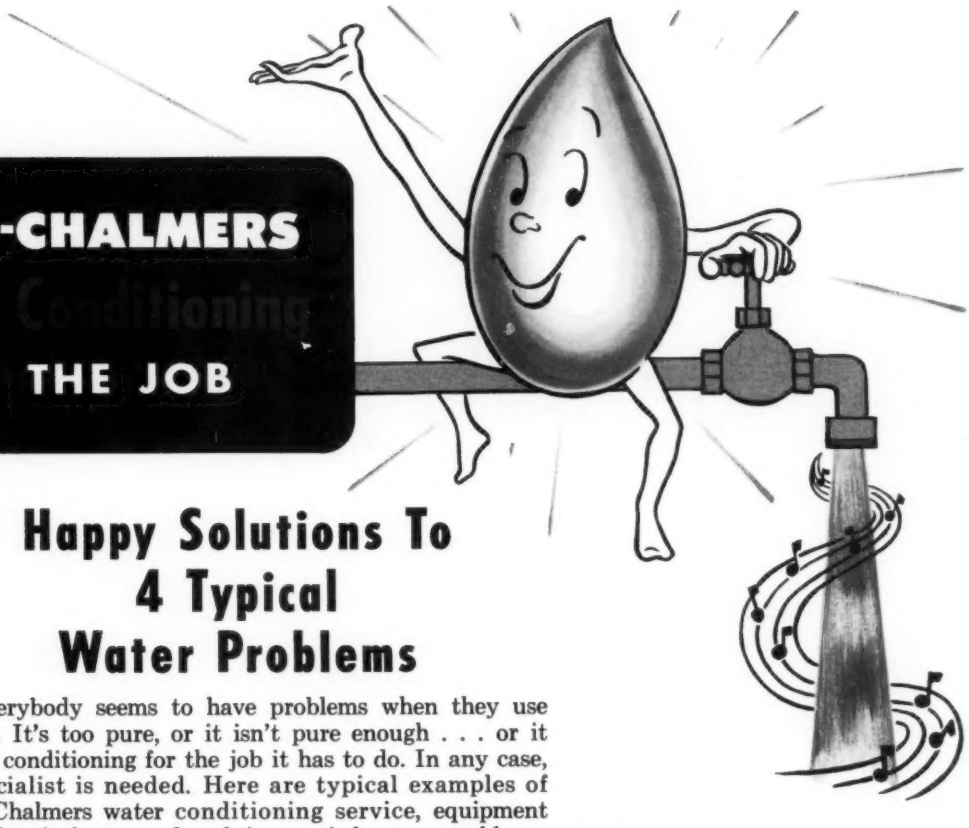
For the "long run," either as a new machinery component or as replacement, specify Allis-Chalmers. Find out more about *real* quality in motors from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5287

ALLIS-CHALMERS
Water Conditioning
ON THE JOB



Happy Solutions To 4 Typical Water Problems

● Everybody seems to have problems when they use water. It's too pure, or it isn't pure enough . . . or it needs conditioning for the job it has to do. In any case, a specialist is needed. Here are typical examples of Allis-Chalmers water conditioning service, equipment and chemicals at work solving varied water problems.

Drought Adds to Woes of River Water Users

CALIFORNIA—Things looked bad at a paper company when the first water samples came in. In fact, one water conditioning company went so far as to say that the alkalinity of the water could never be reduced to a satisfactory level.

But on the assurance of Allis-Chalmers experts, a de-alkalizer was ordered for boiler make-up water.

In the meantime there was a drought. The drought made the river water conditions even worse than they had been, so that by the time the equipment was installed there was real trouble with alkali.

Allis-Chalmers engineers had an unusually tough problem on their hands. Instruction, experiment, on-the-spot service, and a program of constant control have resulted in production of satisfactory boiler make-up.

Saved $60,000 in New Equipment

LOUISIANA—A low pressure industrial steam plant was being supplemented by a 1250-lb boiler. The question arose—can any of the old water conditioning system be used? Preliminary investigation indicated the need for demineralization equipment to get the desired water quality for make-up in the new equipment.

A survey of the records showed that it would be possible to use condensate from the low pressure system as make-up for the high pressure system. This solution of the problem required less modification of equipment than was originally anticipated . . . saved an estimated $60,000.

Stained Glass Has Its Place, But Not in Nursery

ILLINOIS—A nursery was spraying water over the outside of its glass hothouses to control the temperature inside. The method was effective, but the iron stains from the water were troublesome. Allis-Chalmers water conditioning experts recommended A-C's 130 Series complexing agents. This did the job by preventing the iron from depositing on the glass.

Battle with Algae Ends in Knockout

KENTUCKY—A petroleum company is finding out what a lethal weapon Allis-Chalmers new 120 Series algaecide really is. Previously they used sodium hypochlorite, but their cooling tower algae problems were not solved. Now they have complete control . . . using concentrations of only one-half of what is normally recommended. They also say it's easier to handle and apply, and better in every way, than anything they've ever used before.

Get Help on Your Water Problems

Whether you need chemicals, equipment or service, Allis-Chalmers provides an unbiased recommendation based on over 25 years' experience. No problem is too big or too small. Specialists are located in many cities. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5304

Less Gear Shift—More Work Shift With a Bucyrus-Erie Hydrocrane

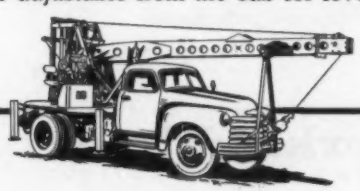
Ordinary crane carriers can't match a truck-mounted Hydrocrane for speed and maneuverability on the highway. The result—the Hydrocrane wastes less time in travel, gives you more profit hours of work.

Compact size so important in traffic gives you extra leeway for maneuvering on narrow roads and streets. Extremely short tail swing allows working close to buildings, tanks and other structures.

Outriggers can't drift down during travel. On the job they set down solidly in seconds, are adjustable from the cab for leveling crane on uneven ground.

Telescoping boom that retracts neatly over cab during travel extends and retracts hydraulically while working—reaches out for loads—slips under wires, beams and overhead lines; over trucks, pipes and other low obstructions.

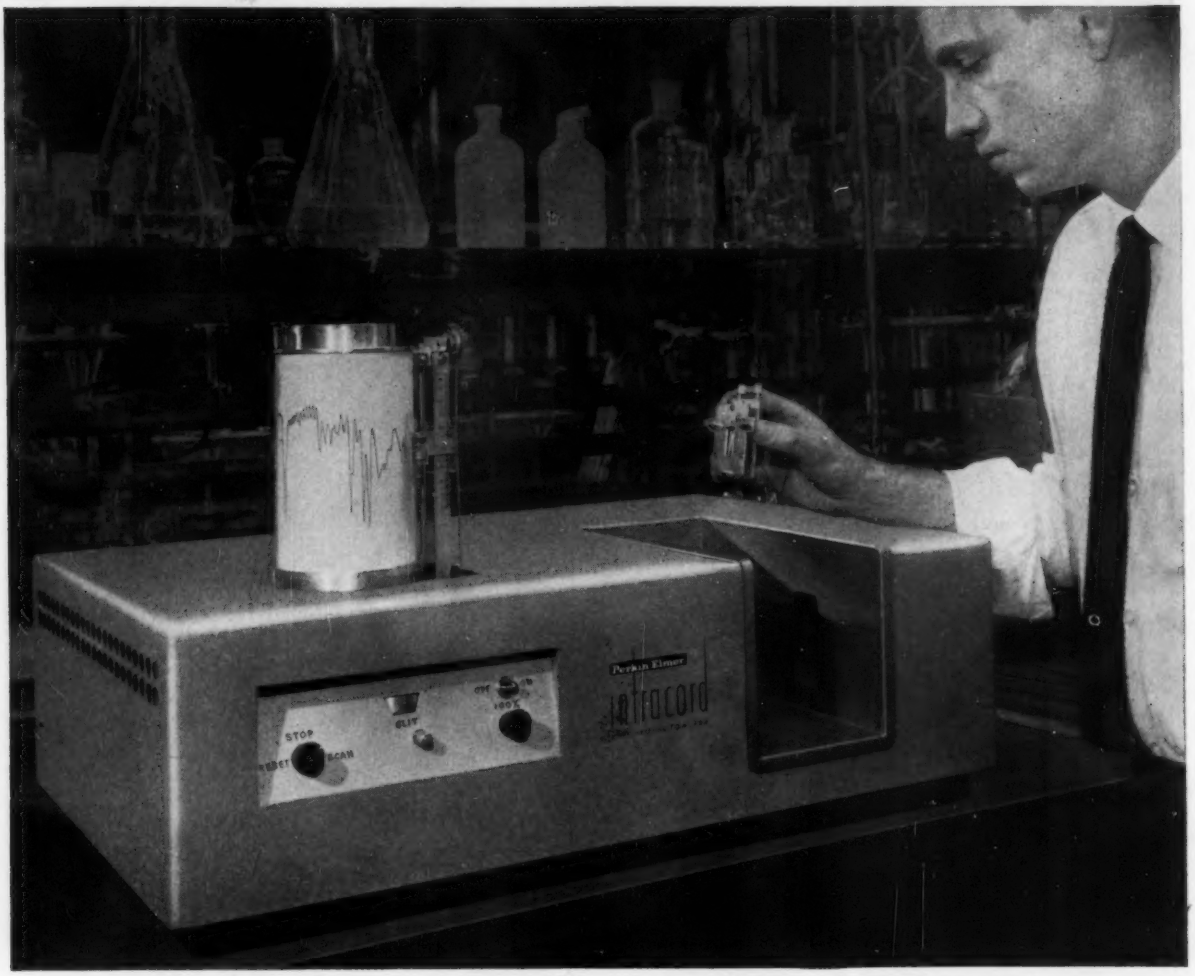
And there's plenty of capacity and reach. The 10-ton Model H-5 has a maximum boom length of 50 feet (plus 10- or 20-ft. jibs); the 5-ton H-3, 38 feet (plus 10- or 18-ft. jibs). Find out all the reasons why Hydrocranes are growing favorites in refineries. See your Bucyrus-Erie distributor for full details. 219H57



BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

For more data on advertised products, use Readers' Service Cards, last page.



a new low cost infrared instrument for the organic chemical laboratory:

THE INFRACORD* DOUBLE BEAM SPECTROPHOTOMETER

The new Infracord Spectrophotometer puts infrared analysis and its advantages within the reach of every laboratory. The result of a 4-year development program by Perkin-Elmer, the Infracord embodies the latest advances in optical, electronic, and mechanical design. A highly efficient *double beam* optical null system, previously available in only the most expensive spectrophotometers, provides the speed, energy, short path length and resolution so necessary for good qualitative and quantitative analysis.

Designed to meet the rapidly expanding use of infrared and analytical techniques, the Infracord is as simple to operate as an analytical balance.

Rugged and compact, the Infracord as an everyday tool for the chemist gives him a fast answer and a permanent record of his work—at the bench. It handles the spectroscopist's routine work. Write for complete information.

*T.M.

NOTE THESE FEATURES:

- double beam measuring system
- atmospheric and solvent compensation
- differential analysis
- linear wavelength vs. transmittance recording
- broad line of sampling accessories
- single unit construction
- requires only 120 volt, 60 cycle power source
- 2.5 to 15 microns in 12 minutes
- instant wavelength reset
- direct recording on notebook size paper
- reproducible performance

PRICE: $3850.00 f.o.b. Norwalk, Connecticut (in U. S. and Canada only)

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

PATENT CHEMICALS, INCORPORATED

MANUFACTURERS OF DYES AND CHEMICALS
FOR THE PETROLEUM INDUSTRY

ANNOUNCES

a bright new

RED

by the Pioneers in Petroleum Dyes

PETROL RED AB4 DRY DYE

PETROL AB4 25% CONCENTRATE

PETROL RED AB CONCENTRATE

Developed for cleaner, easier gasoline coloring. Eliminates pre-dissolving, dusting, operator exposure. Less skill and equipment required. Introduced directly into the finished gasoline. A valuable aid for tank car and tank truck coloring.

Petrol Red AB Concentrate is a 25% dry dye content by weight, pourable at normal temperatures – produces a bright clear standard red shade in gasoline—excellent for masking orange colored gasolines.

SPECIALLY DEVELOPED
FOR GASOLINE MARKING

DESCRIPTION
Petrol Red AB Concentrate

S.G. @ 75° F.	.928
Lbs. concentrate per gallon	7.7
Lbs. concentrate per quart	1.9
Lbs. concentrate per pint	.96

DRY DYE CONTENT

Lbs. per gallon of concentrate	1.9
Grams per gallon of concentrate	877.3
Grams per quart of concentrate	219.3
Grams per pint of concentrate	109.6
Grams per ounce of concentrate	6.8

Being thixotropic, the concentrate may congeal at low temperatures, or upon standing for long periods, becoming fluid when agitated.

Petrol Red AB Concentrate is compatible with other dyes and may be used for blending purposes.

Meets MIL-F-5572 Specifications.

DESCRIPTION
PETROL RED AB4

SOLUBILITY: 1250 grams to 1330 grams per 100 gals. gasoline.

STRENGTH: 97.5-102.5% against type.

SHADE: Bright clear red shade designed to overcome color of orange colored lead fluids.

BENZOL INSOLUBLE CONTENT: Less than 3%.

MOISTURE CONTENT: Less than 2%.

PROPERTIES: High melting point • Non-caking • Designed to overcome lumping in storage, shipping, high temperature and warehousing conditions • Low bulking material.

USES: Excellent for eductor systems, coloring of premium gasolines and general petroleum use.

STANDARD PACKING: 100 pound lever packed fibre containers.

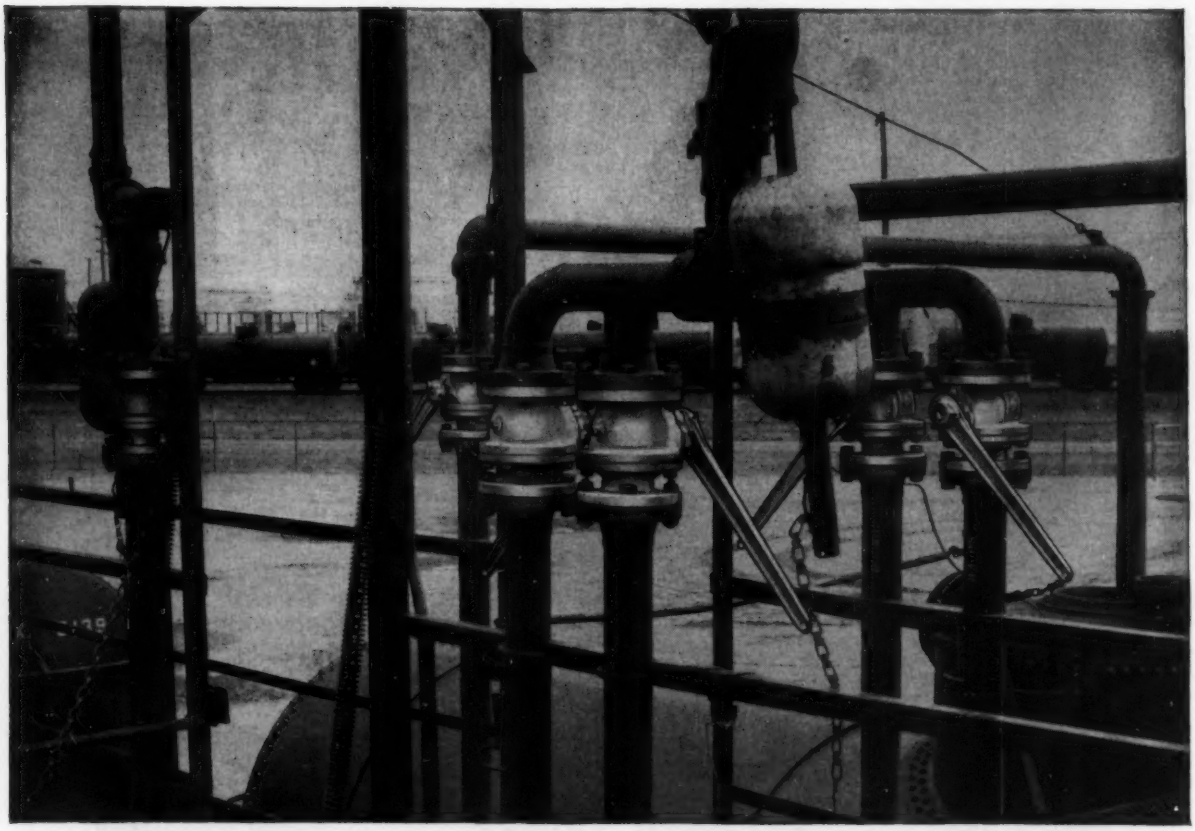
Meets MIL-F-5572 SPECIFICATIONS.

PATENT CHEMICALS INC.

Manufacturing Division: 335 McLean Blvd., Paterson 4, New Jersey

PATENT FUELS & COLOR CORP.

Marketing Division: 2410 Carew Tower, Cincinnati 2, Ohio



He said leaking couldn't be stopped

... *but Rockwood Ball Valves stopped it!*

The resident engineer of a major oil company was skeptical when we told him about the exclusive features of Rockwood Ball Valves. It was impossible, he said, to keep racks free from messy oil conditions due to drippings from valves. But he agreed to replace his old style valves with Rockwood Valves.

He was surprised at the result — *absolutely no leaking from Rockwood Ball Valves.*

It's easy to see why Rockwood Ball Valves are leakproof when you examine them. You'll find—

Full Round Pipe Size Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss.

Quick Opening and Closing — only a quarter turn needed.

Longer wear resistance — Chrome-plated bronze ball withstands abrasion, pitting and scratching.

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

It works as good as it reads! Send coupon today for complete information. Rockwood Ball Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY
1292 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

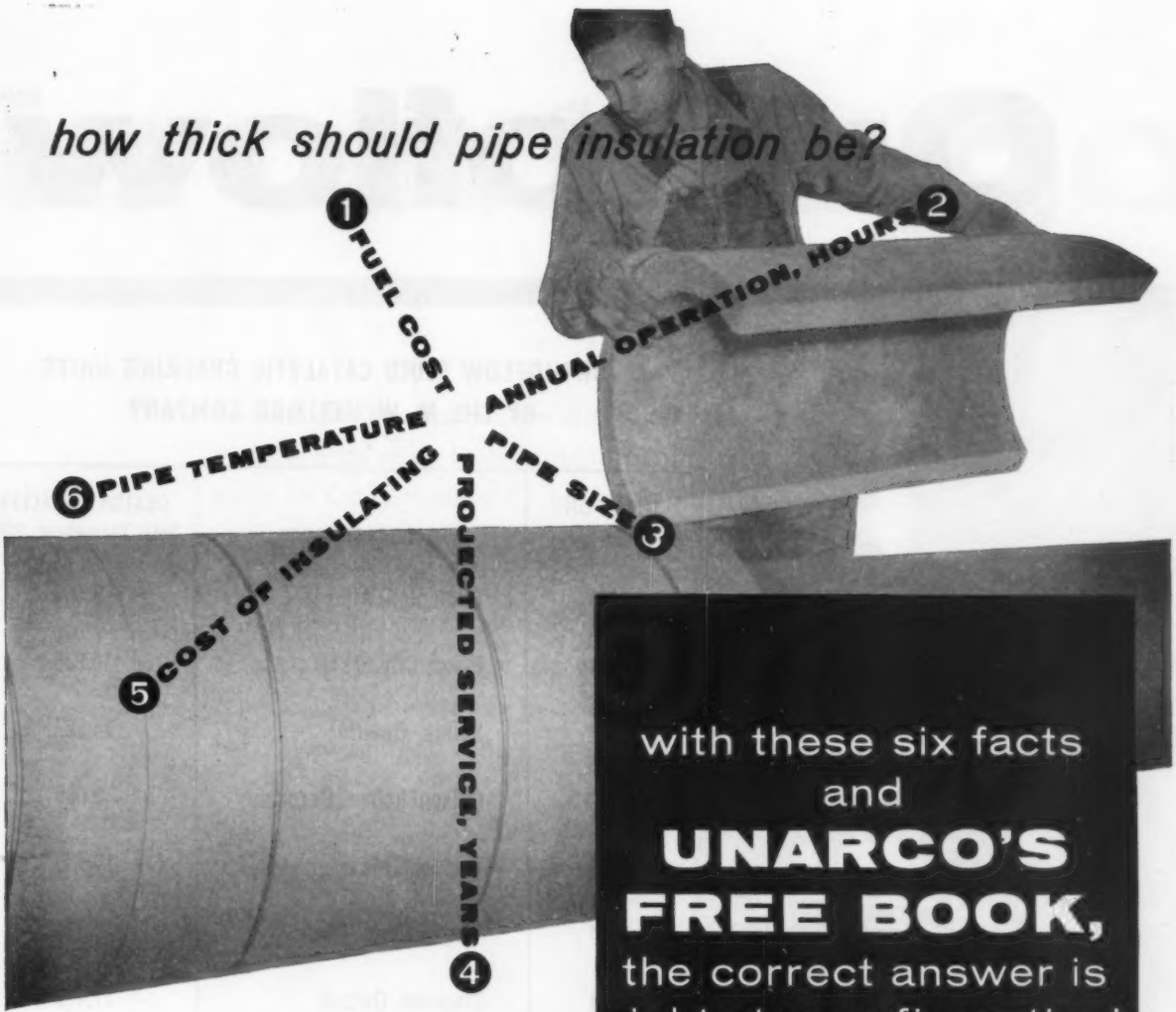
Name.....

Title.....

Company.....

City.....Zone....State.....

For more data on advertised products, use Readers' Service Cards, last page.



with these six facts and

UNARCO'S FREE BOOK,

the correct answer is right at your fingertips!

Too much insulation can be just as wasteful as *too little.* Every insulation-dollar you spend, which is not amortized by fuel-savings, represents needless investment. But, until UNARCO developed "J" Factor Tables, engineers had no *easy way* to determine the most economical thickness.

With today's "J" Factor Tables—and knowing the cost of fuel, hours of operation, life expectancy of the installation, pipe sizes and temperatures, and the cost of insulation, installed—it's merely a matter of ready reference to pick out the right thickness to use.

Time-saving UNARCO "J" Factor Tables should be in every engineer's file. Everything is condensed into five simple charts covering pipe temperatures up to 1200° F. and insulation thicknesses from 1" to 6½". This, and much other pertinent data, is included in UNARCO'S free new 40-page book.

If you are involved in the design or operation of power plants, atomic developments, petroleum or chemical processing, or any other matter requiring conservation of BTUs, mail the coupon today.

UNARCO

All-round dependability, high thermal efficiency, and unmatched ease of installation, make single-layer UNIBESTOS the world's finest pipe insulation.

UNION ASBESTOS & RUBBER COMPANY
1111 West Perry Street, Bloomington, Illinois

Please send me your free 40-page Insulation Booklet containing "J" Factor Tables.

Individual_____

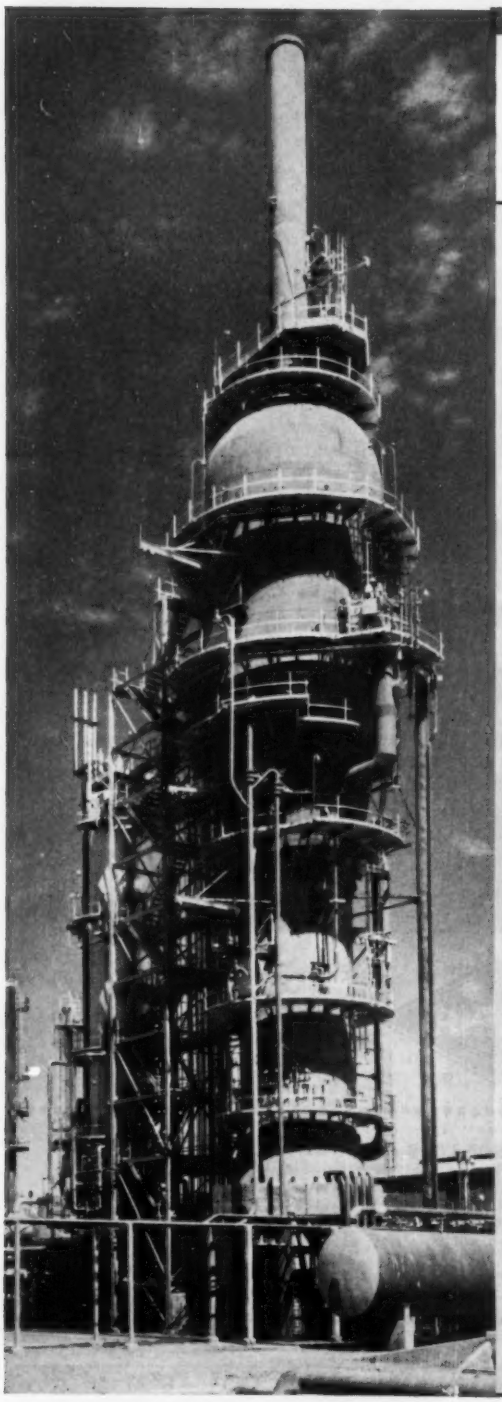
Company_____

Street_____

City, Zone, State_____

For more data on advertised products, use Readers' Service Cards, last page.

Orthoflow®



ORTHOFLOW FLUID CATALYTIC CRACKING UNITS BY THE M. W. KELLOGG COMPANY

DATE ON STREAM	LOCATION	DESIGN CAPACITY Total Throughput, BPD
1951	Edmonton, Alberta	3,500
1951	Ponca City, Okla.	10,939
1952	Sarnia, Ontario	14,027
1953	Gelsenkirchen, Germany*	5,000
1953	Toledo, Ohio	17,705
1954	Smiths Bluff, Texas	26,625
1954	Clarkson, Ontario	17,415
1954	Philadelphia, Pa.	45,000
1955	Amarillo, Texas	9,706
1955	Kwinana, Australia	12,500
1955	St. Boniface, Manitoba	8,374
1955	Enid, Okla.	13,500
1956	Delaware City, Del.*	101,800
1956	Yorktown, Va.	30,618
1956	Puerto La Cruz, Venezuela	14,290
Future	Mataripe, Brazil	20,493

® *Trademark of The M. W. Kellogg Company*

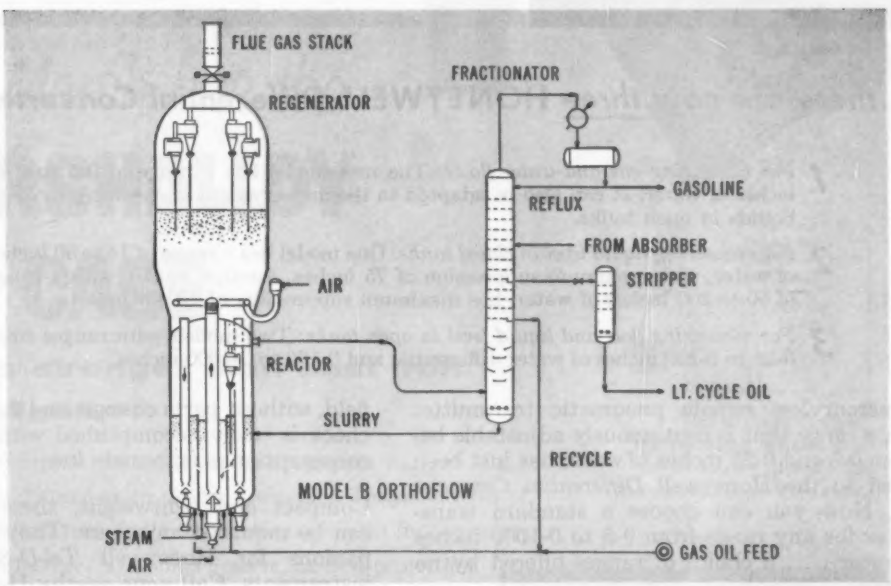
**Process and Engineering only*

For more data on advertised products, use Readers' Service Cards, last page.

is on the go

Low initial investment, low direct operating expense, and low maintenance costs have brought world-wide recognition in a few short years to the Orthoflow Fluid Catalytic Cracking Unit—a development of Kellogg's many years' experience in engineering and erecting fluid cat crackers of other types.

For refiners contemplating expansion with the earliest possible on-stream date, Kellogg engineers will be glad to interpret the economics and efficiency of the Orthoflow vertical design in terms of individual refinery conditions and requirements.



Refinery Process Division

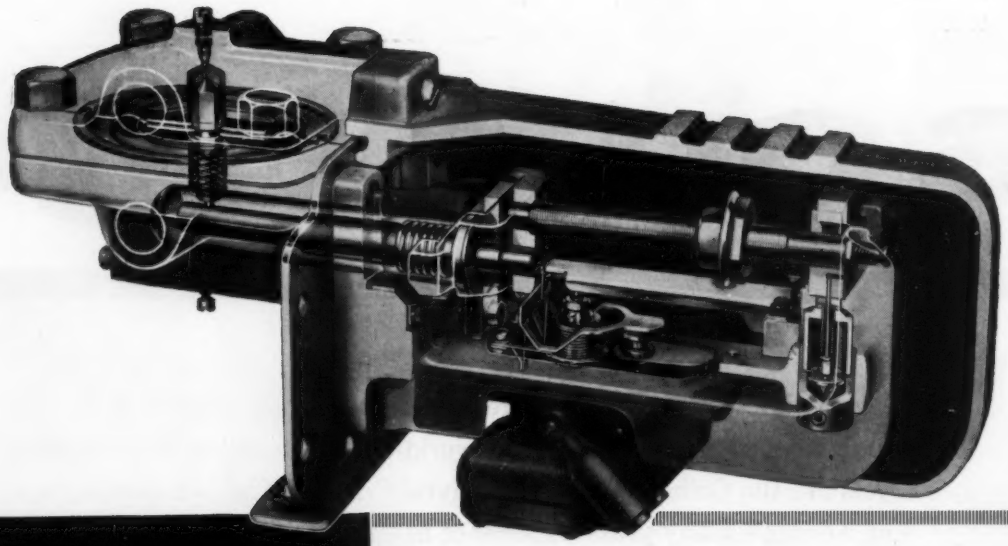
The M. W. Kellogg Company

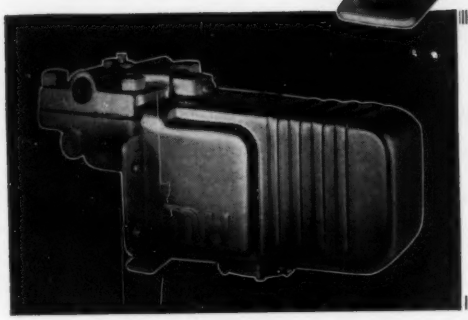
711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto · Kellogg International Corp., London · Kellogg Pan American Corp., New York · Societe Kellogg, Paris · Companhia Kellogg Brasileira, Rio de Janeiro · Compania Kellogg de Venezuela, Caracas

For more data on advertised products, use Readers' Service Cards, last page.





For full-range control of flow and liquid level

...there are now three HONEYWELL *Differential Converter* models

1. *For measuring gas and water flows:* The new model has a range of 0-5 to 0-25 inches of water. It can also be adapted to the measurement of specific gravity of liquids in open tanks.
2. *For measuring liquid level in closed tanks:* One model has a range of 14 to 50 inches of water, with maximum suppression of 75 inches. Another model, with a range of 50 to 200 inches of water, has maximum suppression of 200 inches.
3. *For measuring flow and liquid level in open tanks:* Two models with ranges from 0-20 to 0-200 inches of water differential and 0-100 to 0-1000 inches.

A mercuryless remote pneumatic transmitter with a range that is continuously adjustable between 0-5 and 0-25 inches of water has just been added to the Honeywell *Differential Converter* line. Now you can choose a standard transmitter for any range from 0-5 to 0-1000 inches of water . . . a choice of ranges offered by no other manufacturer.

The *Differential Converter* measures gas and liquid flow or liquid level with accuracy within ±1% . . . and with rapid response, upscale and down. Range is continuously adjustable in the field, without parts change, and field calibration check is easily accomplished with weights. Air consumption is extremely low.

Compact and lightweight, these transmitters can be mounted anywhere. They're ideal companions for Honeywell *Tel-O-Set* miniature instruments. Call your nearby Honeywell sales engineer for details. He's as near as your phone.

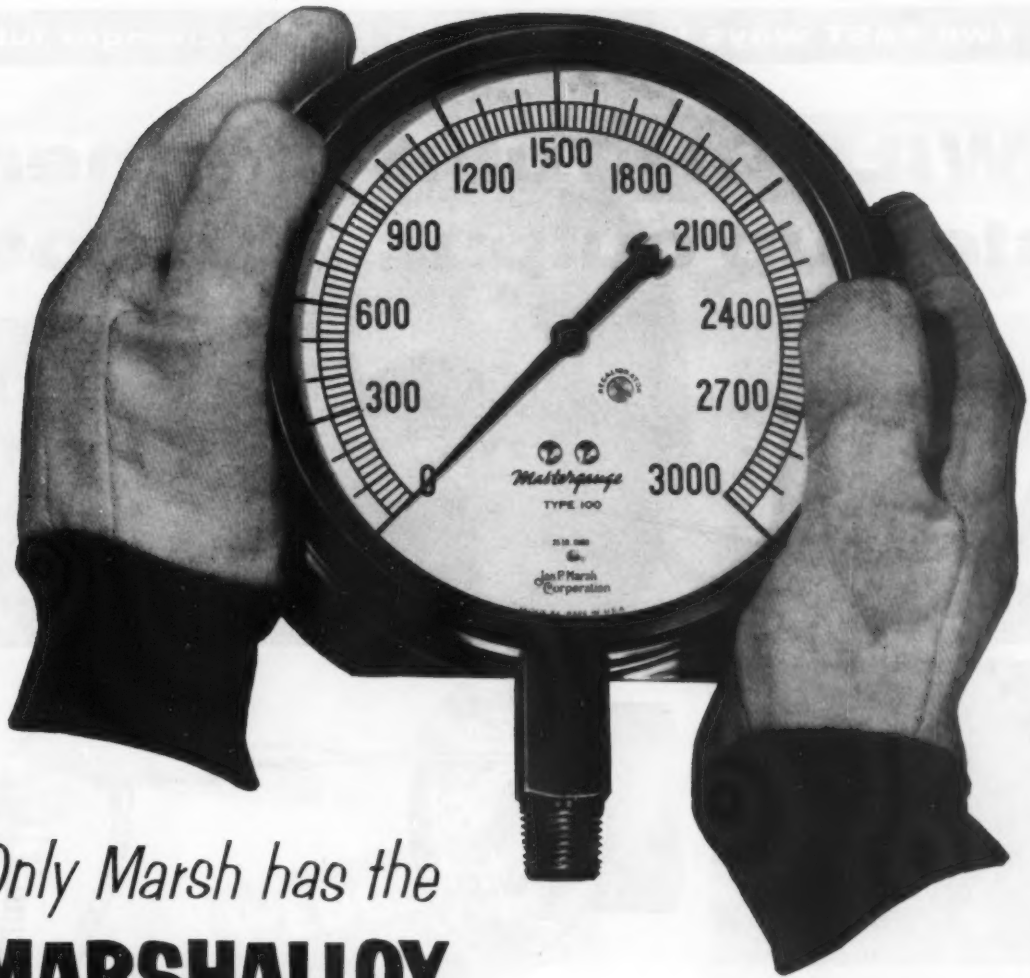
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Bulletin 2280-1, "*Differential Converter* Liquid Level Transmitter"; Catalog 2321, "Flow Meters," and Specification 248, "*Differential Converter* Flow Transmitter."

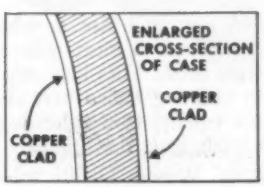
MINNEAPOLIS-**Honeywell**

BROWN INSTRUMENTS

First in Controls



Only Marsh has the **MARSHALLOY CASE**



The strength of steel; the corrosion resistance of solid copper . . . that's the Marshalloy copper-clad case.

Four times stronger than cast iron
One-third lighter

There's nothing temperamental about a pressure gauge . . . provided it's built right and given proper protection. The basic units of Marsh Gauges—socket, tube and movement—are known for the care given to their manufacture. Such units deserve the best protection . . . and *get it* in the Marshalloy case. Here is a steel case of boiler-plate-thickness, heavily clad with copper inside and out . . . lighter, but many times tougher . . . protected against the ravages of corrosion. It is available only in Marsh Gauges.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.*
Dept. R, Skokie, Illinois

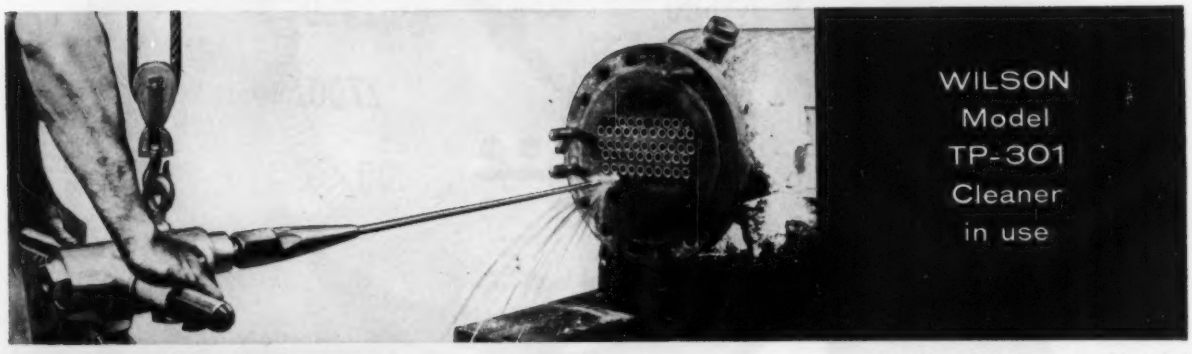
Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

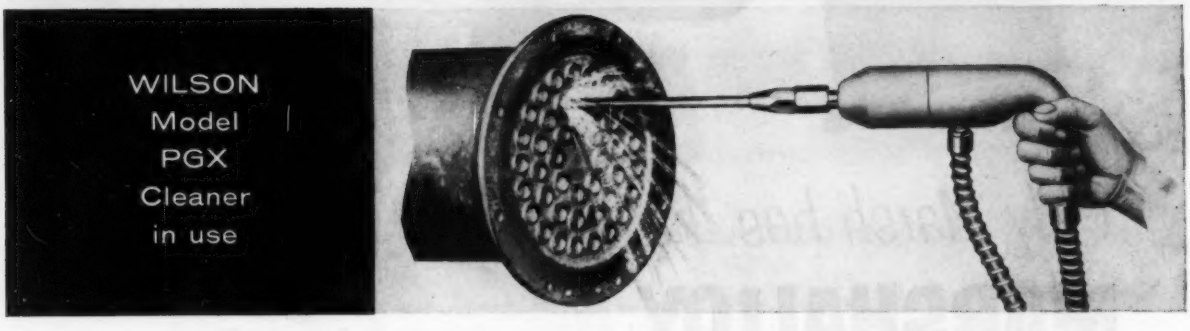
MARSH GAUGES

PRESSURE GAUGES • THERMOMETERS • WATER REGULATING VALVES • HEATING SPECIALTIES

Two FAST ways to clean fouled heat exchanger tubes

WILSON Tube Cleaners step up output...cut costs





These two Wilson high speed tube cleaners are designed to meet today's high production needs. They help step-up profits by cleaning fouled heat exchanger tubes rapidly, thus increasing output and minimizing downtime.

The powerful Wilson TP-301 tube cleaner is a positive air driven, rotary shaft, drill type tool. It is suitable for vertical or horizontal use in tube ⅜' O.D. to 2⅞" O.D. and up to 40 feet in length. Operating speed is up to 3,500 rpm at 90 psi utilizing 130 cfm. The Wilson TP-301 will quickly clean such deposits as calcium, carbonates, sulfates, sulphites, silicates, chlorides, and many other types of organic matter. Tube is scavenged with air or water while cleaning. No preliminary arrangements are necessary. Equipment goes back on stream rapidly.

Wilson also offers the Model PG tube cleaner for tubes from ¼" to 1" ID. This versatile light-weight tube cleaner weighs only three pounds... requires maximum of 35 cfm at 90 psi.

PGX TUBE CLEANER

The Wilson PGX tube cleaner is also a positive drive (not geared down) high speed, hollow rotary shaft, air-driven scavenger type cleaner. It washes out the tube and debris while it cleans and, at the same time, keeps the drill bit cool. There's no worry about jammed, burned out bits.

Designed for intermediate size tubes from ½" to 1½" ID, the Wilson Model PGX obtains maximum power at 90 psi using 75 cfm. It's suitable for horizontal or vertical applications ... requires only one man to operate.

• • •

Use these Wilson cleaners for: gas coolers, sulfite evaporators, glycerine evaporators, fuel oil heaters, polymerization units, humidifier tubes, tar heaters, water heaters, crude column heaters, small transfer lines, as well as miscellaneous heaters, condensers and evaporators.

TW-878

Representatives in principal cities

THOMAS C. WILSON, INC. • 21-11 44th Ave., Long Island City 1, N. Y.

Cable address: "Tubeclean", New York

WILSON

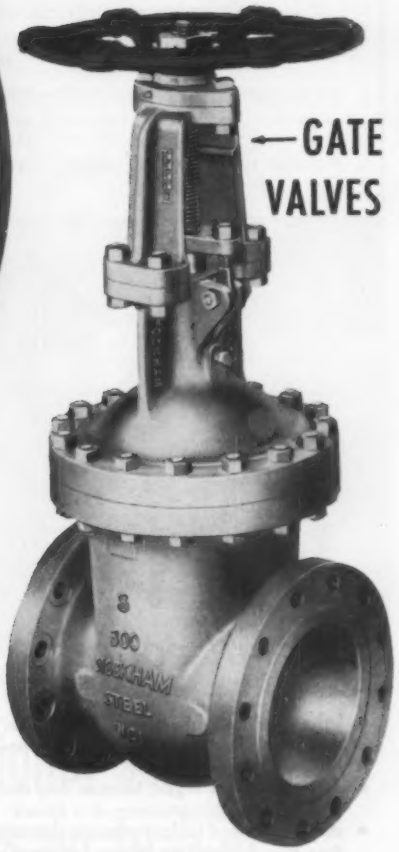
TUBE CLEANERS • TUBE EXPANDERS

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander Catalog No. 88.

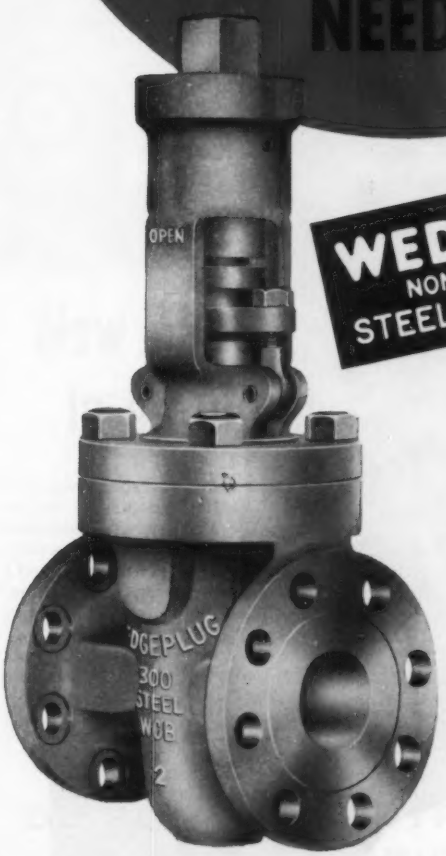
STOCKHAM

· GATE · GLOBE · ANGLE · PLUG · CHECK

MEETS YOUR GENERAL SERVICE STEEL VALVE NEEDS



←GATE VALVES



WEDGEPLUG
NON-LUBRICATED
STEEL PLUG VALVES

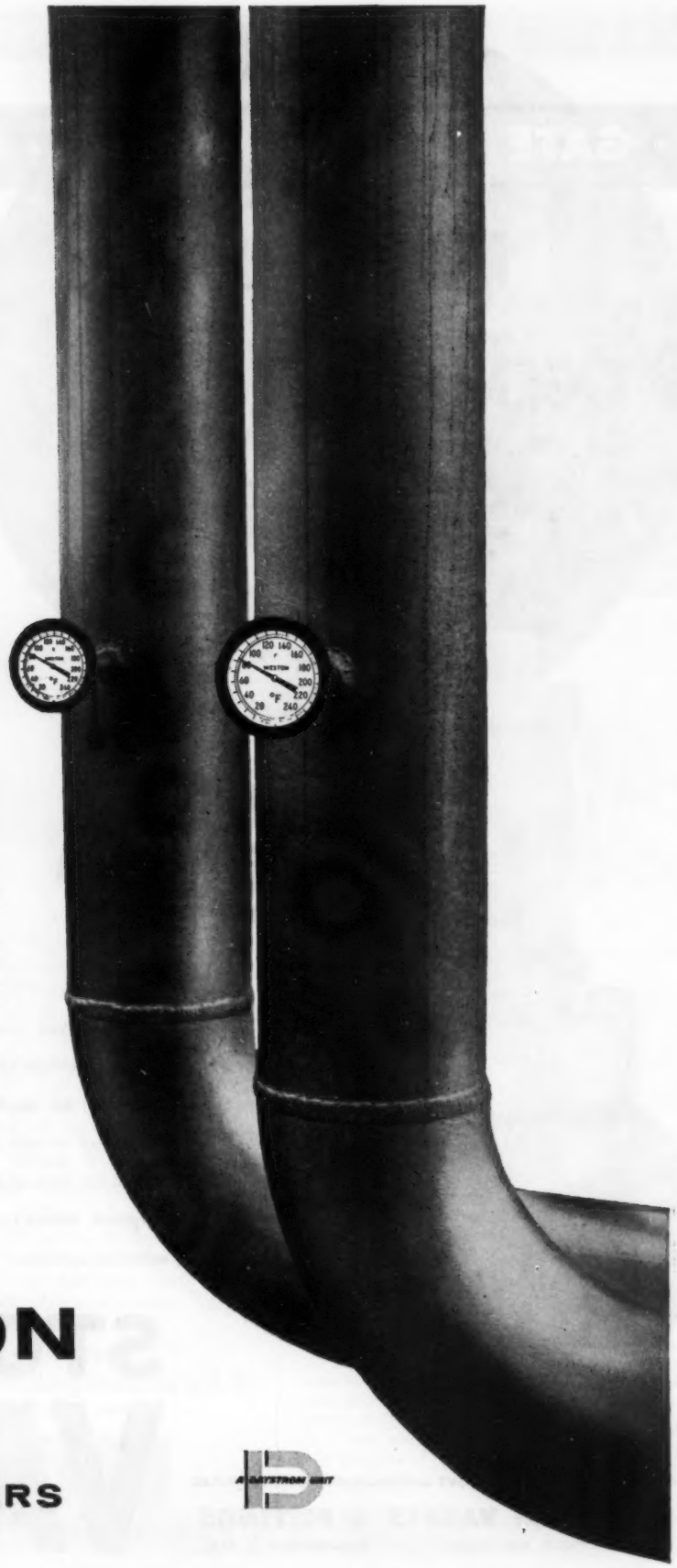
WHETHER you require gate, globe, angle, check or plug valves, Stockham can supply scientifically-designed steel valves that meet all applicable specifications. A precision-finished valve that is both dependable and economical can be furnished for manual or for automatic operation . . . For special purposes, valves can be supplied in alloy steels with a wide selection of trims.

Write for Stockham Catalog SV2 and Wedgeplug Catalog W-1-56

STOCKHAM VALVES & FITTINGS
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALA.

STOCKHAM STEEL VALVES

For more data on advertised products, use Readers' Service Cards, last page.



RIGHT
on all counts!

- **inherently right,** because of Weston's exclusive design and advanced manufacturing techniques
- **easy-to-read right,** because they read with on-the-button accuracy, *at a glance*
- **and right** for budget reasons, because they give trouble-free service for years — bring thermometer costs *'way down*

Weston bimetal thermometers are available in types, sizes and ranges for industrial as well as laboratory needs. Bulletin T13 gladly sent on request. Weston Electrical Instrument Corporation, Newark 5, New Jersey.

WESTON
Bimetal
THERMOMETERS

A DAYSTROM UNIT

Remarkable resistance to heat and harsh chemicals

PROPERTIES OF "ARMALON" FELTS

GENERAL

Highly resistant to strong acids and bases at all temperatures.

Unaffected by water, common fuels, lubricants, hydraulic fluids, solvents.

High anti-stick properties.

Low coefficient of friction.

For FILTERING MATERIALS—tetrafluoroethylene felts

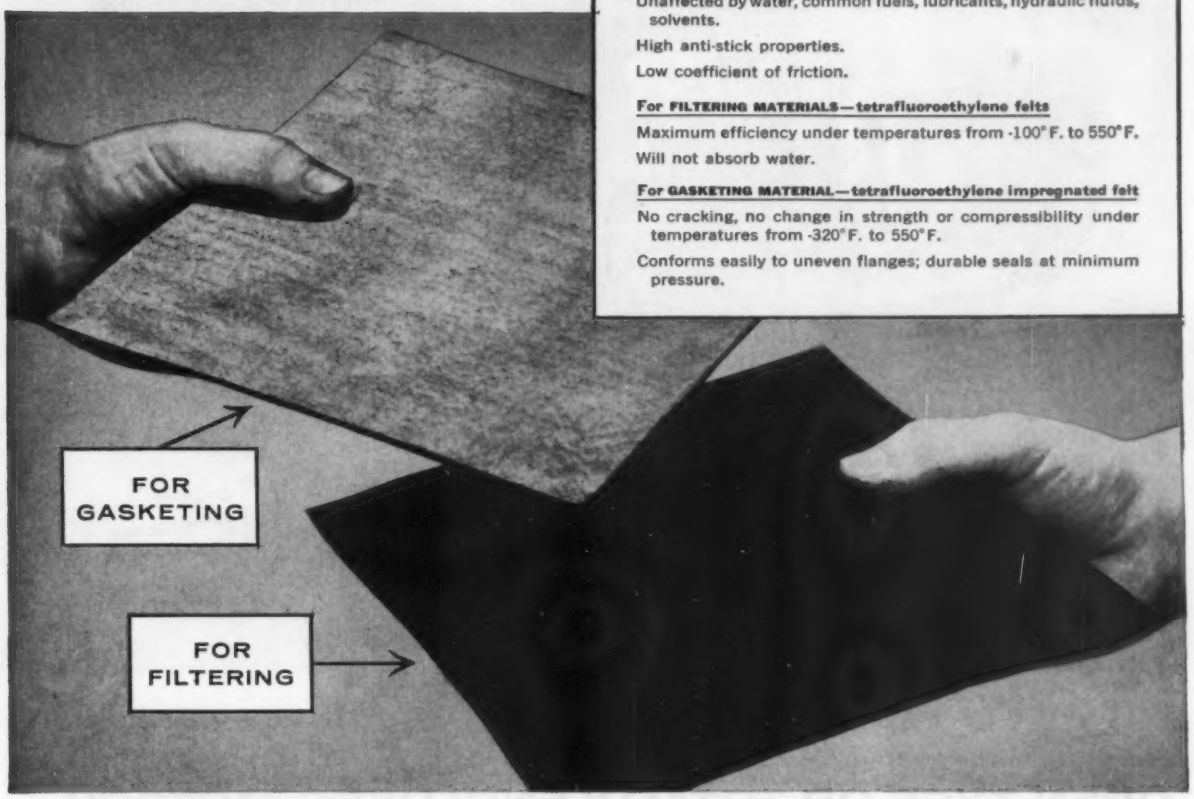
Maximum efficiency under temperatures from -100° F. to 550° F.

Will not absorb water.

For GASKETING MATERIAL—tetrafluoroethylene impregnated felt

No cracking, no change in strength or compressibility under temperatures from -320° F. to 550° F.

Conforms easily to uneven flanges; durable seals at minimum pressure.



New ARMALON® felts show exceptional service life in strong corrosives, temperatures up to 550° F.

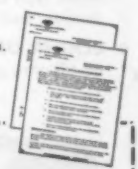
Corrosion-resistant filters and gaskets of new "Armalon"* tetrafluoroethylene resin assure extraordinary long life felts where other materials fail entirely. They've proved their superiority in systems handling strong acids and bases—at temperatures from -320°F. to 550°F.

"Armalon" is the new felted form of Du Pont's "Teflon"** tetrafluoroethylene resin, available in two constructions—one for filtering, the other impregnated for gasketing†. "Armalon" is inert to water, common fuels, lubricants, hydraulic fluids, solvents and corrosive chemicals.

FILTERS of "Armalon" remove fine particles at high flow rates with minimum pressure drop. Anti-stick property of "Armalon" means longer service life, easier cleaning.

GASKETS of "Armalon" seal securely and last months, even years, longer than other materials. Advantages include substantial reductions in costly replacement shutdowns.

For more facts that may help you find a place for "Armalon" felts in your operations, fill out and mail the coupon. You'll receive Du Pont's free descriptive bulletin, including specifications.



*"Armalon" is Du Pont's registered trademark for its tetrafluoroethylene felts and impregnated felts.
**"Teflon" is Du Pont's registered trademark for its tetrafluoroethylene fiber.
†"Armalon" tetrafluoroethylene impregnated felt is covered by U. S. Patent 2,764,506.

DU PONT INDUSTRIAL COATED FABRICS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Dept. PR7-5
Wilmington 98, Delaware

Please send me descriptive bulletin on "Armalon" felts.

Name_____ Position_____

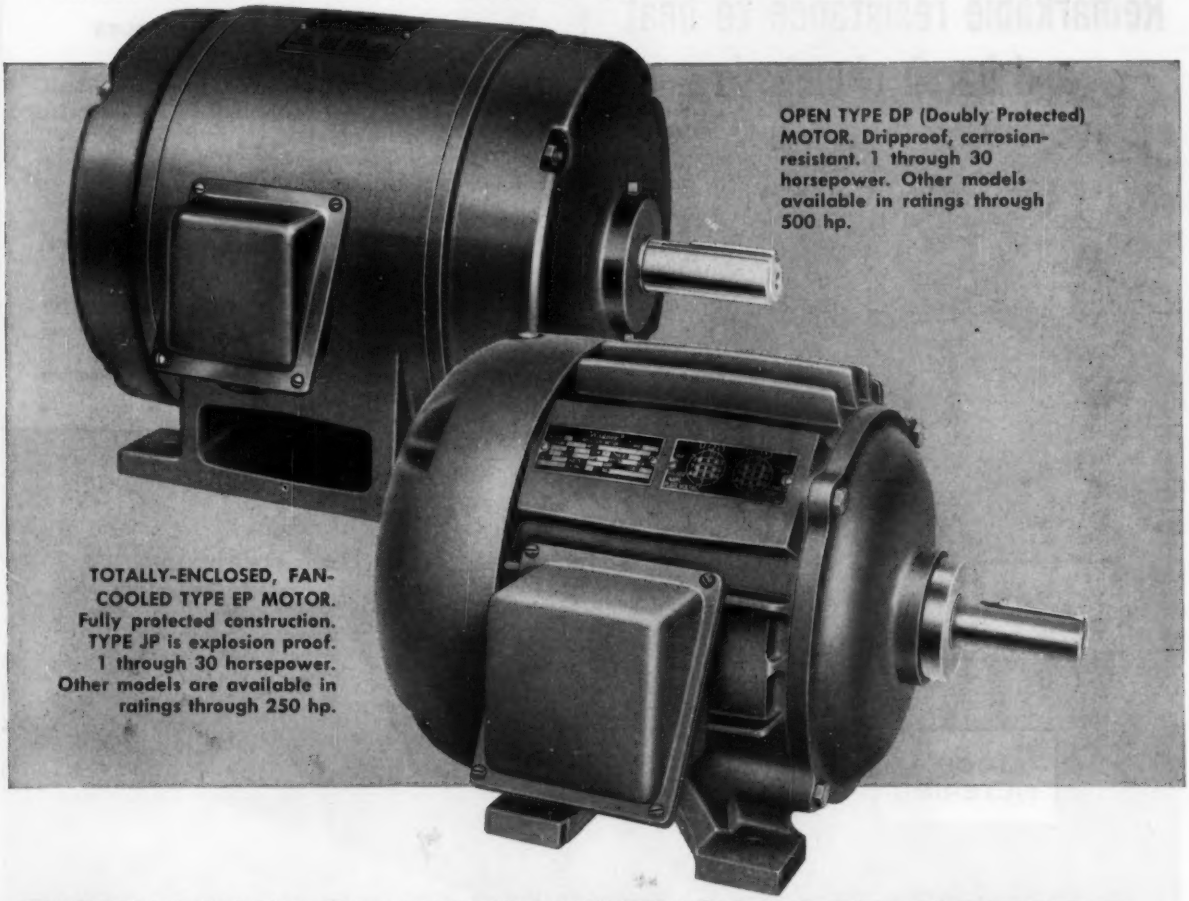
Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY


OPEN TYPE DP (Doubly Protected) MOTOR. Dripproof, corrosion-resistant. 1 through 30 horsepower. Other models available in ratings through 500 hp.
TOTALLY-ENCLOSED, FAN-COOLED TYPE EP MOTOR. Fully protected construction. TYPE JP is explosion proof. 1 through 30 horsepower. Other models are available in ratings through 250 hp.

OPEN TYPE OR TOTALLY ENCLOSED MOTORS...

Wagner offers MORE for your motor dollar!

- **MORE POWER IN LESS SPACE** . . . These motors are built in NEMA frame sizes 182 through 326 U. They pack more power into less space for easier handling and stocking—require less space for installations.
- **CORROSION-RESISTANT FRAMES** . . . Both types are built with rugged, corrosion-resistant cast iron frames. Motor feet are cast as an integral part of the frame for maximum strength and rigidity.
- **THE TYPE OF PROTECTION YOU NEED** . . . Type DP motors have completely dripproof—virtually splash-proof enclosures; while type EP is totally enclosed, fan-cooled for complete protection; and type JP adds explosion proof features.
- **COOLER OPERATION** . . . Special baffles direct a cooling flow of air through the DP motor. Types EP and JP are fan-cooled and have ribbed frames to increase the surface area for more efficient cooling.
- **LONGER BEARING LIFE** . . . These motors can be re-greased when desired to prolong bearing life. Fresh grease can be added—old grease removed through openings provided in the bearing housing.
- **WAGNER DEPENDABILITY** . . . These two motors have the same high Wagner quality, will give the same long life performance, that have made Wagner Motors a *known* value for sixty-five years.
- Let a Wagner field engineer, expert on motor applications, show you how these motors can be applied to your needs. Call the nearest of our 32 branch offices, or write us. Bulletins MU-202 and MU-203 give complete information on these Wagner Motors. Write for your file copies today.

M57-4

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

SOLVAY quality CAUSTIC POTASH

in types, forms and packages to fit your requirements

TECHNICAL GRADE

SOLVAY Technical Caustic Potash is the quality standard grade product that has been recognized by users as a leader in quality and dependability for over three decades. It is produced in both liquid and dry forms.

The dry product is produced in flake, small flake, walnut and solid forms, all of which are unusually low in iron, light in color and produce solutions of exceptional clarity. It is available in steel drums as follows:

Flake, 90-92%	**350 lbs. net**	(12-, 18-inch caps and full open head)
	100 lbs. net	
Small Flake, 90-92%	**400 lbs. net**	(12-, 18-inch caps and full open head)
	100 lbs. net	
Walnut, 90-92%	**200 lbs. net**	
	100 lbs. net	
Solid, 90-92%	**675 lbs. net**	
	100 lbs. net	

SOLVAY Technical Caustic Potash in liquid form is available in 45% strength in both returnable and non-returnable 55-gallon steel drums, 660 lbs. net, and in 45-52% strength in specially-lined tank cars of 4,000, 6,000, 8,000 and 10,000 gallons capacity.

MERCURY CELL GRADE

SOLVAY is the pioneer producer of this super-quality grade of commercial caustic potash. This material, which set a new standard for the industry for whiteness and purity, contains only trace quantities of metals and chloride, and is chlorate-free. It is available in both flake and liquid forms in the following packages:

Flake, 90-92%	**Steel drums—350 lbs. net**	(15-inch cap and full open head)
	100 lbs. net	
Liquor, 45%	**Returnable 55-gal.—660 lbs. net**	
	Non-returnable 55-gal.—660 lbs. net	
Liquor, 45-52%	**Specially-lined tank cars—4,000, 6,000, 8,000 and 10,000 gallons**	

Mail coupon for complete data, sample!

SOLVAY PROCESS DIVISION
ALLIED CHEMICAL & DYE CORPORATION
61 Broadway, New York 6, N. Y.

Please send me without cost:

Samples of Technical Grade Caustic Potash

☐ Flake ☐ Small Flake ☐ Solid ☐ Walnut

☐ Liquid, 45% strength ☐ Liquid, 49-50% strength

Samples of Mercury Cell Caustic Potash

☐ Flake ☐ Liquid

Caustic Potash fact book ☐

Name_____

Position_____

Company_____

Phone_____

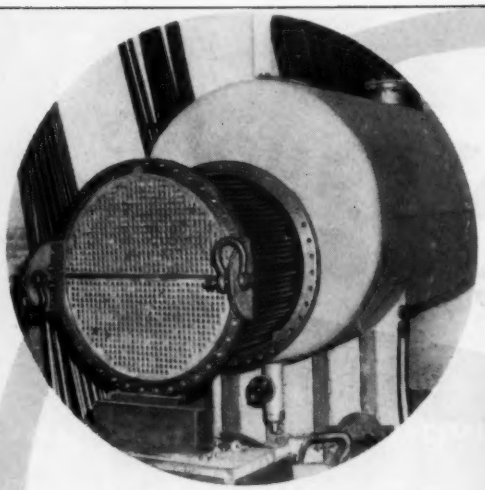
Address_____

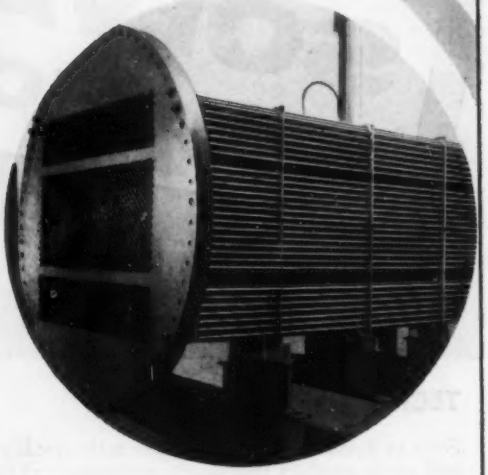
City_____ Zone_____ State_____ ED-5

SOLVAY®

Aluminum Chloride • Vinyl Chloride • Sodium Nitrite
Calcium Chloride • Potassium Carbonate • Soda Ash
Caustic Potash • Snowflake® Crystals • Caustic Soda
Sodium Bicarbonate • Ammonium Chloride • Chlorine
Methylene Chloride • Hydrogen Peroxide • Chloroform
Ammonium Bicarbonate • Monochlorobenzene • Cleaning Compounds • Ortho-dichlorobenzene • Para-dichlorobenzene
Methyl Chloride • Carbon Tetrachloride

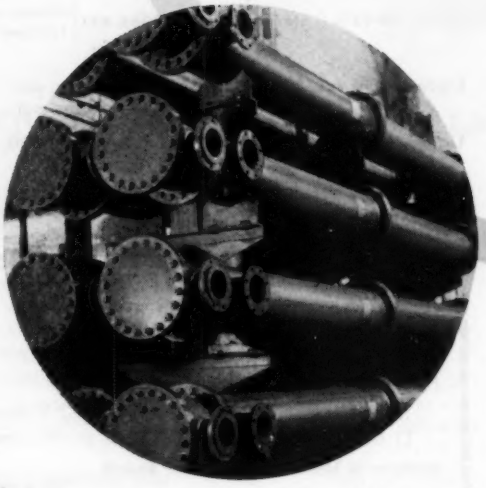
For more data on advertised products, use Readers' Service Cards, last page.





VULCAN

HEAT EXCHANGERS



Vulcan exchangers are custom-built to meet specified process requirements or to designs supplied by the customer. Conditions ranging from liquid air to Dowtherm, high vacuum to high pressure can be met.

Shell and tube types are fabricated fixed bundle or removable bundle with floating or outside packed head. U-bend design is offered for economy. Proper choice of details is made on expansion joint, tube sheet covers, baffling and multi-pass arrangement. Emphasis is on quality construction, TEMA and ASME codes.

Vulcan is equipped to handle rolling of tubes with controlled torque expanders. Modern radial drills assure close tolerance drilling, reaming and grooving of tube holes. Inspection techniques include X-ray, Halide, Zyglo, Dy-chek as well as high vacuum and high pressure testing.

Materials of construction include stainless steel, aluminum, nickel, copper, Monel, Inconel, Hastelloy, Karbate, Carpenter #20, cupro-nickel, Everdur, Herculloy, Ampco, phosphor bronze, aluminum bronze. All welded design is standard.

Write for bulletins "Vulcan Plant Facilities" and "Chemical Plant Equipment." If interested in fermentation processes ask for bulletin on "Vulcan Fermenter Cooler."

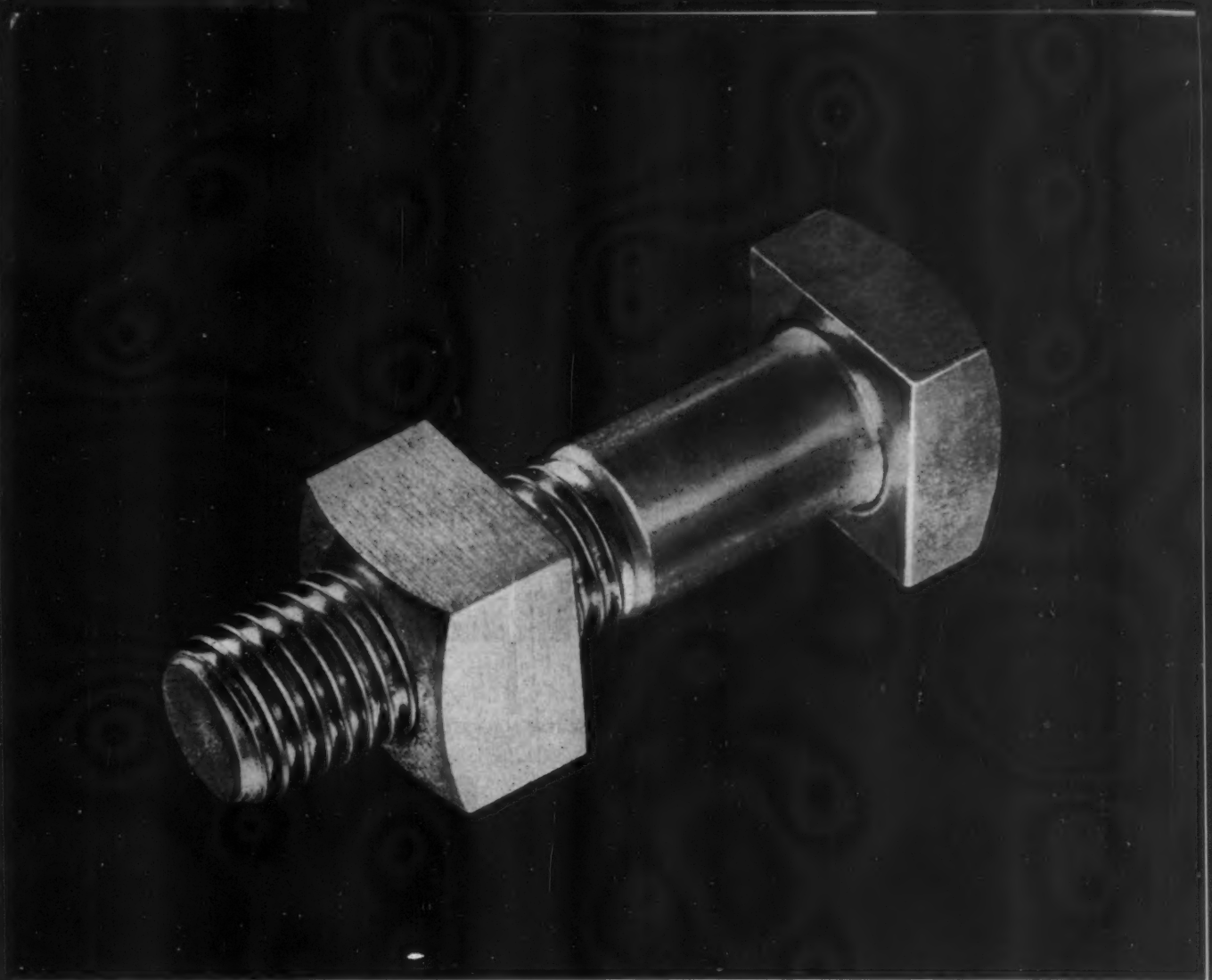
VULCAN MANUFACTURING DIVISION

VULCAN-Cincinnati, Inc. General Offices and Plant, CINCINNATI 2, OHIO

(FORMERLY THE VULCAN COPPER & SUPPLY CO.)

HOUSTON BOSTON CHARLOTTE, N. C. ST. LOUIS DENVER SAN FRANCISCO

VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION



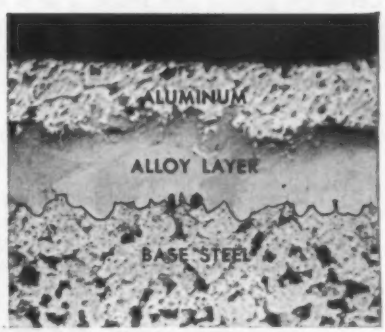
The Bethalume process produces an unusually uniform coating, ensuring clean threads for good fit.

Bethalume Coating Gives Fasteners Better Resistance to Corrosion

Fasteners used in corrosive atmospheres have a much longer service life, and require little or no maintenance, when protected by Bethlehem's Bethalume coating—a hot-dip coating of pure aluminum.

The Bethalume coating is effective in enabling fastener items to withstand the effects of corrosive atmospheres because it adds the permanence of aluminum to the strength of steel. The coating is tightly bonded to the base steel, and is uniform over the entire surface of the fastener. The coated threads are clean and smooth-fitting.

Why not look into the advantages of the Bethalume coating for your fasteners applications? A telephone call to the nearest Bethlehem sales office will bring one of our representatives to your desk promptly.



Photomicrograph of Bethalume coating. Pure aluminum is bonded to base steel by iron-aluminum alloy.

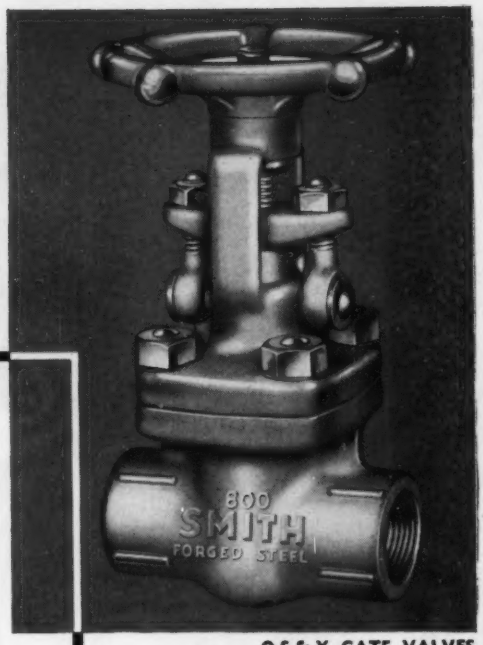
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

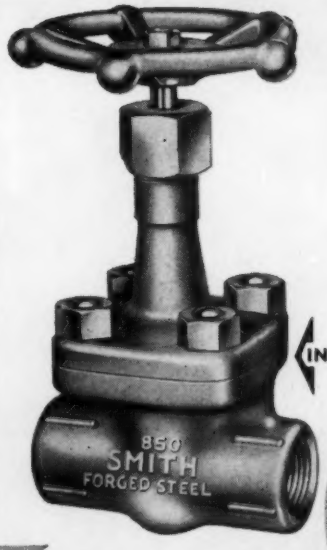
BETHLEHEM STEEL

BETHLEHEM STEEL

BETTER VALVES



O S & Y GATE VALVES
Sizes ¼" - 2", Inclusive



INSIDE SCREW VALVES • Sizes ¼" - 2", Inclusive

Smith FORGED STEEL Valves

. . . *for* BETTER SERVICE

to the Refinery, Chemical, Petrochemical and allied Process Industries

Forged Steel for maximum strength and highest safety factor.

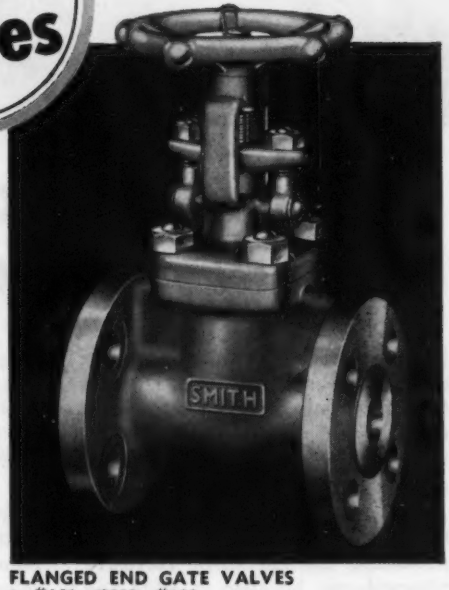
Bolted Bonnet plus **Flexitallic Gasket** for positive, tight bonnet joint.

Stem—375 Brinell—Rolled Threads (30% stronger than cut threads). Centerless ground stem shank, 6 to 8 micro finish, for unusually smooth operating stem and longer packing life.

Tear Drop designed gate, combined with accurately broached guides, insures perfectly controlled operation in high temperature, high pressure service.

500 Brinell Gate plus **Diamond Hard** chrome faced seats minimizes seizing, galling and abrasive wear.

These and other special features combine to make SMITH VALVES Stronger, Safer, Easier to Operate and Maintain . . . and what's really important, they Cost No More than other valves in the same rated pressure and temperature classifications.



FLANGED END GATE VALVES
• #150; #300; #600
Sizes ½" - 2" inclusive • A. S. A. Dimensions

NEW ENGLAND VALVE Corporation

P. O. BOX 1047 • WORCESTER, MASSACHUSETTS

West Coast Distributors: BETHLEHEM SUPPLY CO., LOS ANGELES, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

There is a specific A. P. Green Castable for every refractory application in the Petroleum Field. Methods of installation, including troweling, pouring, and "gun" application vary with the particular characteristics of the job. Each A. P. Green castable refractory is specifically designed to provide the required properties of insulation, strength, abrasion resistance and refractoriness for high efficiency operation.

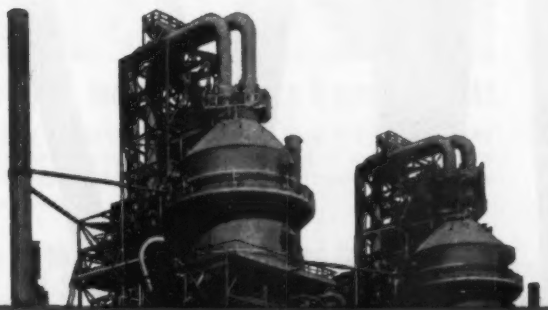
For detailed information and recommendations write the Engineering Department of the A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

KAST-SET
A. P. Green KAST-SET is a rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700°F.

KAST-O-LITE
A lightweight, insulating castable refractory recommended for temperatures up to 2500°F. It is used for complete monolithic linings in all types of oil stills and heaters, tar stills, air heaters, heat treating furnaces, flues and stacks, and for furnace hearth insulation.

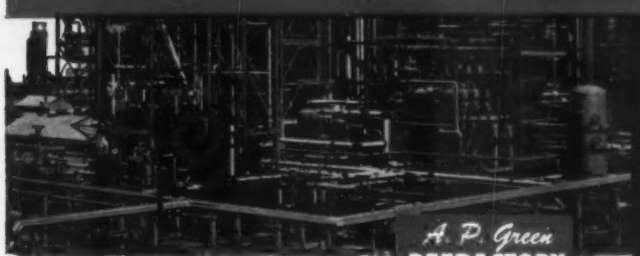
CASTABLE INSULATION NO. 20
A hydraulic-setting castable for temperatures up to 2000°F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters.

CASTABLE BLOCK MIX
A hydraulic-setting castable insulation for temperatures up to 1600°F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight.



A.P. GREEN

HIGH QUALITY REFRACTORY AND INSULATING CASTABLES ASSURE HIGH EFFICIENCY OPERATION OF PETROLEUM EQUIPMENT



Esso Standard Oil Company's fluid catalytic cracking units at the Baton Rouge Refinery where A. P. Green products are in use.

A. P. Green REFRACTORY PRODUCTS

CASTABLES FOR GUN APPLICATION

SK-7 and KS-4
were designed for use in combination to form composite linings in catalytic regenerators, reactors, and other petroleum equipment. Frequently a lining utilizing only SK-7 or KS-4 will fulfill the requirements of the job.

SK-7
Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency. Ideal lining for ducts, flues and breechings.

KS-4
This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion.

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS:
Mexico, Mo.—Woodbridge, N. J.—Sulphur Springs, Texas, Jackson, Oak Hill, South Webster, Ohio • Philadelphia, Pa. • Troy, Idaho

IN CANADA:
A. P. Green Fire Brick Company, Ltd.—Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

When you're fighting the weather as well as heat loss

Workmen applying Thermobestos insulation to an expansion loop in a process line.

Specify

J-M THERMOBESTOS® the heat insulation designed for outdoor process industries

Here's proof that rugged physical strength and high insulating efficiency can be combined in one material. J-M Thermobestos is strong and rigid, yet light enough for easy handling and fast application. It is not damaged by prolonged wetting. Its hard composition resists crushing and will withstand unusual service abuse. The low conductivity compares favorably with other accepted industrial insulations.

This unique combination of properties means excellent temperature control and minimum maintenance cost for oil refineries, chemical processing plants and other plants with outdoor vessels and hot piping.

Made from calcium hydrosilicate, Thermobestos is molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends. Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints. In pipe insulation form, it comes in a complete selection of sizes up to 24″ x 3″ half-sections. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses. For further information write to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JM

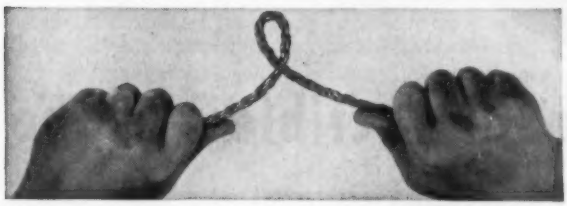
Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For more data on advertised products, use Readers' Service Cards, last page.

Tuffy® Sling Bulletin

Reporting the Outstanding Performance of Union Wire Rope's Machine-Braided Wire Fabric Slings.

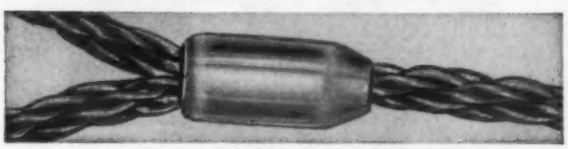


Tuffy's a Hard One to Kink... and a Breeze to Unkink!

You'll find it next to impossible to kink a Tuffy sling by hand. If you succeed, even with the aid of a vise, see how easily the braided fabric can be straightened out with no material damage.

Tuffy's Streamlined Ferrule is Pressed On Over Tucked Eye-Splices for 100% Strength of Sling

Tremendous machine pressure swages Tuffy's smooth-edged metal ferrule around the tuck splice. Metal virtually "flows" into the braided fabric interstices. This compressive treatment gives the eye of the sling 100% of the strength of the wire fabric. Eyes *stay* spliced!



Tuffy Hoist Line Delivers Big Extras of Dependability and Long Wear

Tuffy Hoist Line is a special rope construction for hoisting on all types of over-head, stiff leg and mobile cranes, derricks and clamshells. Combines extra flexibility and toughness to absorb load shocks. Tuffy slings and hoist lines work with hand-and-glove harmony to cut hoisting costs and downtime in every kind of materials handling.

Your Tuffy Distributor will help you give Tuffy Slings and Hoist Lines "the works" test on the job you choose

FREE! Send Coupon for Handbook now

For Canada, Safety Supply Co., Toronto

Give Tuffy "the Works," then Take a Long Look at the Increase in Sling Service You Get Per Dollar

Tuffy asks no coddling. Put Tuffy slings on your toughest jobs. Give them the "full treatment" of hard service. They'll take it, and then some. And you'll be ahead in dollars saved by Tuffy's longer wear and faster handling. The secret is the patented machine-braided construction of Tuffy slings. It produces a combination of extra flexibility and extra toughness never possible with ordinary wire rope — and a big step ahead of costly hand-braided slings. This 9-part Tuffy fabric is precision-braided by machine in a way that eliminates the inequalities of hand-braiding. Tuffy Slings have no cores. Even when one of the 9 parts is cut or broken, it does not result in stranding.

Watch Your Men Sling Loads Faster, Easier, with Greater Safety

Tuffy fabric and Tuffy's pressed-on ferrule team up to speed up sling work. The high flexibility and kink resistance of Tuffy slings make for smooth handling, and the Tuffy ferrule makes a pulled-out splice virtually a thing of the past. Because the ends of the ferrule are swaged flush with the machine-braided strands, there are no projections to snag on loads or injure hands. No wonder handlers work faster, safer, with Tuffy slings.

union Wire Rope **corp.**

2284 Manchester Avenue, Kansas City 26, Mo.

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand

MY NAME_____ TITLE_____

COMPANY NAME_____

ADDRESS_____

3. CITY_____ ZONE____ STATE_____

5 STEPS

in making an almost indestructible turbine

The rotor of a Terry solid-wheel turbine is a single forging of special composition steel. It is first rough turned in two operations, as shown, and then two cuts are taken to mill the semi-circular buckets from the solid metal. The wheel at the top has been finished, ready for mounting on the shaft. *The result is a single-piece wheel with no parts to loosen or wear out.*

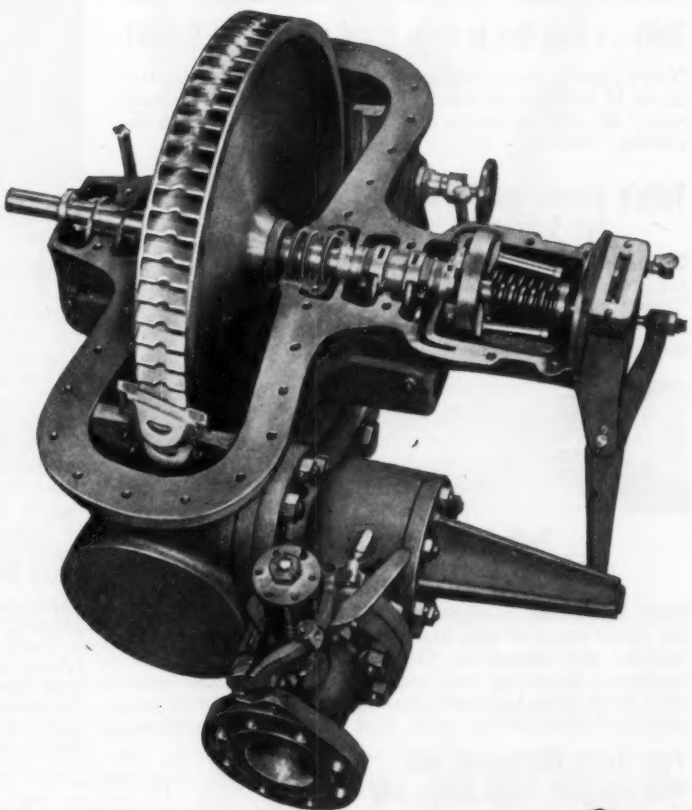
Blade wear, which might occur after many years of usage, is not important, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. They have a one-inch clearance, and are further protected by the projecting rims at the sides of the wheel.

The Terry solid-wheel turbine is an extremely reliable piece of equipment. Write for details—today. Ask for a copy of bulletin S-116.

THE
TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1204



TERRY

you can meet any lubrication specification if you

BLEND WITH ENJAY PARANOX®

(DETERGENT-INHIBITOR ADDITIVES)

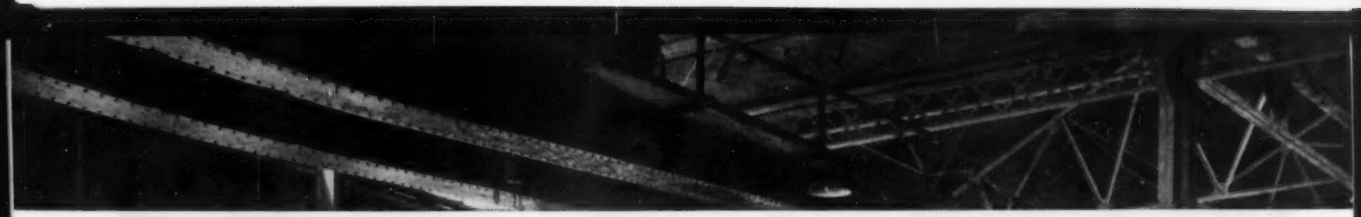
Blended with Paranox, lubricants can be compounded to combine *both* minimum wear and maximum engine cleanliness characteristics. That's why more and more refiners and blenders are relying *exclusively* on Paranox in formulating lubricants for heavy duty equipment and all engines that are subjected to tough operating conditions. Through years of intensive research and development work with manufacturers and oil companies, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Contact the Enjay Company today.

ENJAY

Pioneer in Petrochemicals

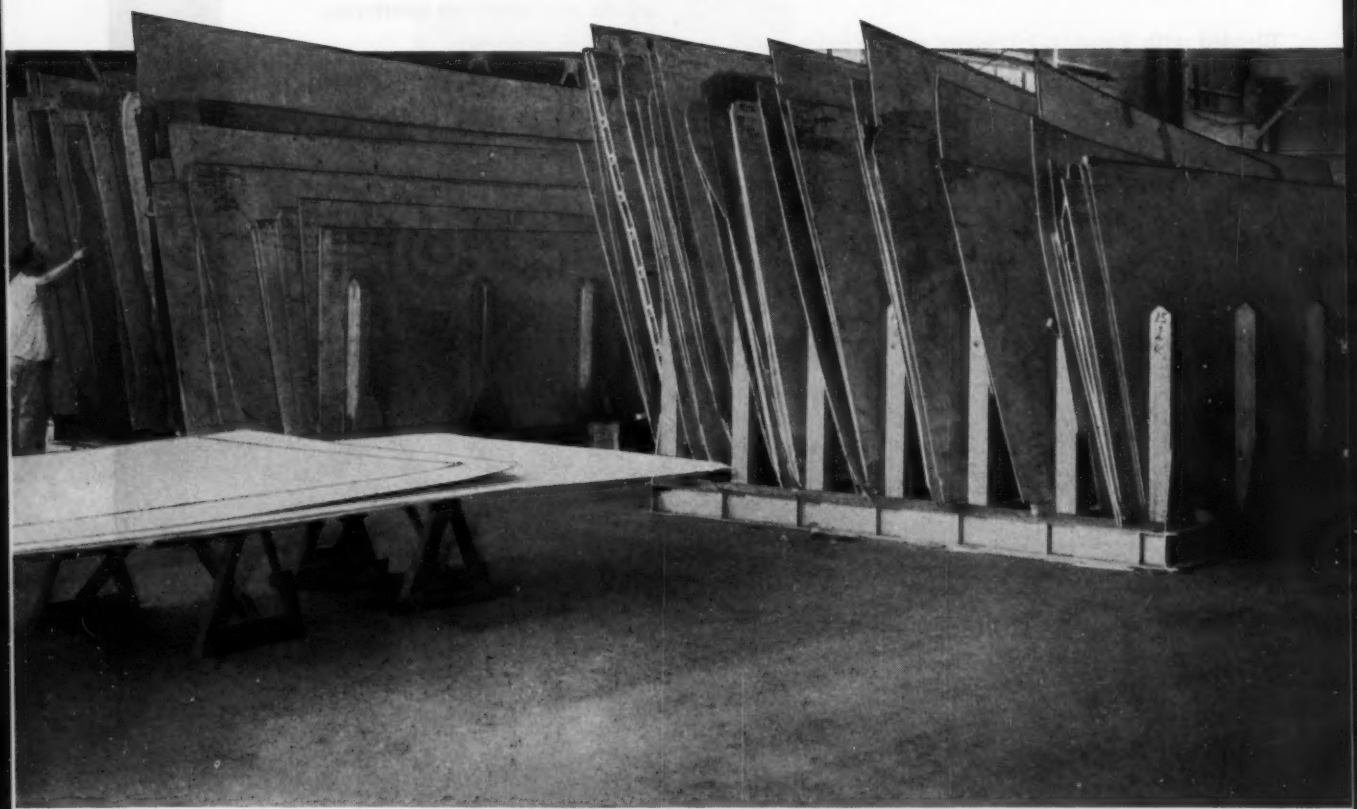
ENJAY COMPANY, INC., 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa



Available now from Carlson

...any size and shape you want in Types 405, 410 and 430 stainless plate



Carlson's stock of Types 405, 410 and 430 chromium stainless plate is the largest ever. You can order plates, large or small, and get delivery in a few days. Types 405 and 410 find wide application in petroleum processing. Type 430 is generally used for furnace parts, annealing boxes and nitric acid storage tanks. Consider the 400 series if you need stainless plates right now.

Prompt delivery isn't your only advantage. These grades cost less than chromium-nickel stainless steels and if you need irregular shapes and sizes, experienced men with specially designed equipment can cut your plates and get them out in a hurry. Carlson provides a complete service with a flexible operation to take care of your specific requirements. This combination of stock, specialization and service saves you time and money, *gives you what you want when you want it!*

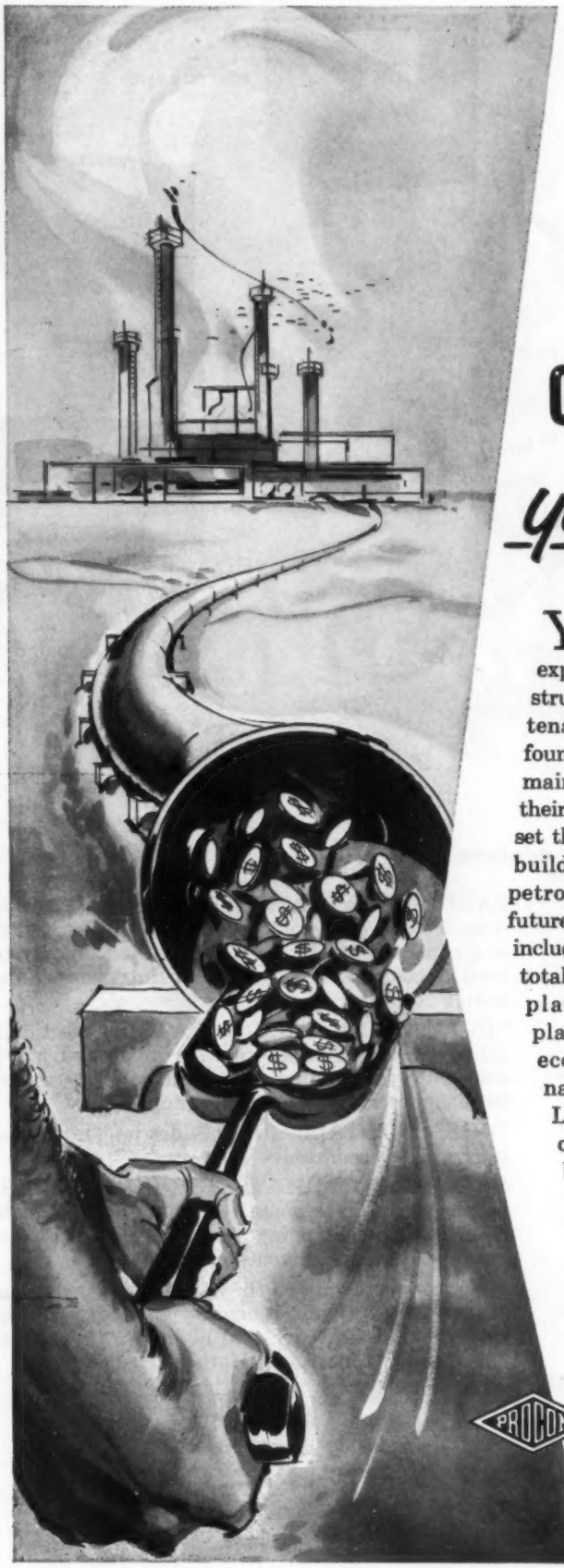
G.O.CARLSON *Inc.*

Stainless Steels Exclusively

THORNDALE · PENNSYLVANIA

District Sales Offices in Principal Cities

PLATES • PLATE PRODUCTS • FORGINGS • BARS • SHEETS (No. 1 Finish)



How much will your new plant cost.... *after you've paid for it?*

You may have learned from bitter experience that original design and construction can vitally affect your maintenance costs. Many executives have found that a big worry today is high maintenance costs, because yesterday their plant was not best planned to offset them. The way Procon designs and builds a chemical, petrochemical or petroleum refining plant helps keep future maintenance costs low because we include evaluation of the economics of total plant operation and upkeep in our planning. There are Procon-built plants all over the world operating economically today on this maintenance-minded construction principle. Let us show you how ease and economy of operation and maintenance can be built into your plant.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

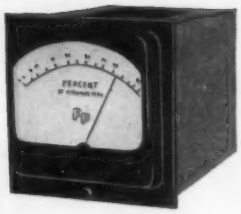
PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA

PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND

PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

For more data on advertised products, use Readers' Service Cards, last page.

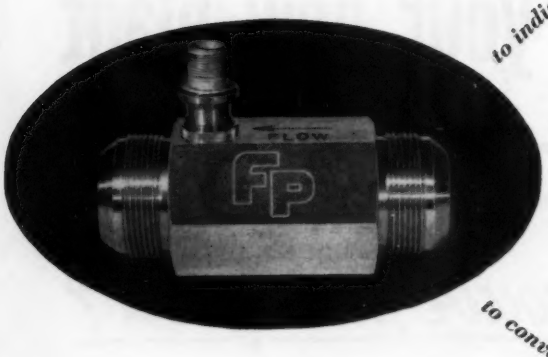


PANEL FLOW RATE INDICATOR

to indicate flow

to indicate steady state flow condition

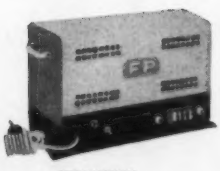
IN-LINE DIGITAL INDICATOR



to totalize flow for batch processes

DIGITAL TOTALIZER

to convert transient flow for analog output



FREQUENCY MULTIPLIER-CONVERTER

get flow information in any form you need it

. . . with F&P turbine meters and readout devices

Here's the ideal solution to flow metering problems characterized by high temperature, high pressure, high flow volume, or rapid flow transients. Fischer & Porter turbine meters are inherently among the most accurate flow measuring devices available today . . . providing measurements accurate to ½% of instantaneous rates.

The low inertia, axially balanced rotor of the F&P turbine meter gives optimum response to rapidly changing flow rates . . . providing positive information on changes as soon as they *begin*, not after they happen. A basic frequency output, directly proportional to flow, provides a common language easily fed to indicating, recording, or transmitting equipment. You can have digital or analog indication . . . oscilloscope recording . . . circular or strip chart recording . . . digital totalizing . . . transmission or any combination of these. Here are just a few of the Fischer & Porter output devices you can dovetail with one or more turbine meters:

PANEL FLOW RATE INDICATOR: Provides scale reading in desired flow units or in percentage of maximum flow. Includes amplifier which may be used to feed EPUT meters or integrators, and analog converter.

"IN-LINE" DIGITAL INDICATOR: Direct digital readout of flow information in desired gravimetric or volumetric units. Automatically selects turbine meter outputs by flow range.

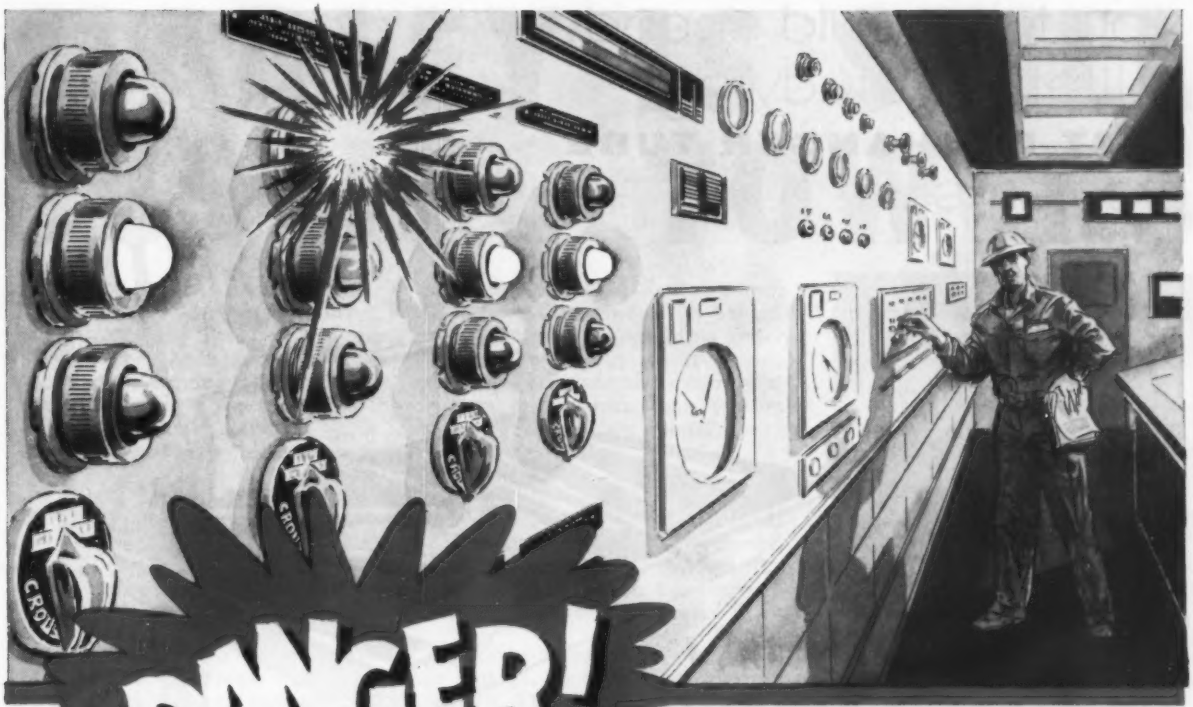
DIGITAL TOTALIZER: Provides integrated flow information accurate to ½%.

FREQUENCY MULTIPLIER-CONVERTER: Extremely rapid response to transient flow signals. Sampling of eight points per cycle provides more information than conventional means.

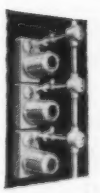
For complete data on the F&P turbine meter and some of the systems it makes possible, write for catalog. Address request to Fischer & Porter Co., 957 County Line Road, Hatboro, Penna.

FISCHER & PORTER CO.

Complete Process Instrumentation

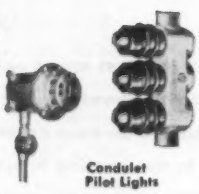


. . . instantly signaled by Crouse-Hinds *Visularms*®

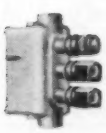


Condulet Visularms

Condulet Horns, Bells & Sirens

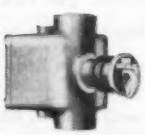


Condulet Pilot Lights



Condulet Pushbutton Stations

Condulet Instrument Housings



Condulet Selector Switches

*Dust-ignition-proof.

In oil refineries, chemical plants, synthetic rubber plants — wherever constant watch of processing is necessary — Crouse-Hinds Condulet® *Visularms* provide visual indication of process conditions, and instant control of manufacturing equipment.

By means of pilot lights (and bell, horn or siren signals where desired) *Visularm* indicates normal or abnormal temperature, liquid level, pressure, or other conditions which can be electrically coupled to the circuit.

Explosion-proof or dust-tight and weather-resistant construction* assures maximum safety in hazardous locations. Compact designs minimize space required on control or panel boards . . . are easy to install.

A Visularm system delivers substantial savings by eliminating the necessity for buying individual components . . . housing them . . . and wiring your own system completely.

Two- or three-light styles may be mounted either vertically or horizontally. For audio warning, any number of *Visularms* may be used to operate a single horn, bell or siren.

Visularms are just one of hundreds of items in process control board equipment offered by Crouse-Hinds. Only a few are shown at left. For full information on the complete line, call your nearest Crouse-Hinds distributor, or write . . .

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.
Crouse-Hinds Company of Canada, Ltd.: Toronto, Ont.

Offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus-Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington RESIDENT REPRESENTATIVES: Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport.

you, too, could spend a lifetime studying **HEAT EXCHANGER TUBE** problems...

but there's an **easy** way to save yourself that kind of work

Simply pick the brand of Heat Exchanger Tube that starts out in life as a CONTINUOUS-CAST billet . . . Scovill Phosphorized Admiralty. Only in Scovill's unique continuous casting process do *many* carefully controlled melts of alloy BLEND together in the casting process to produce such SOUND and UNIFORM billets for subsequent hot extrusion and cold-drawing into Heat Exchanger Tube. Exceptional uniformity of chemical composition and uniform distribution of the inhibitor (phosphorus) mean longer tube life.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

simply put it up to... **SCOVILL**

HEAT EXCHANGER TUBE FOR APPLICATIONS FROM MARINE TO PETROCHEMICAL... FROM COMPRESSOR INTERCOOLERS TO "CAT-CRACKER" EXCHANGERS... IN THESE POPULAR ALLOYS
Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Cupro Nickel 10%—20%—30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

ISC57

MARLEY IS STILL TESTING TOWERS

Here are the current results—a consecutive list of **ALL** acceptance tests conducted by Marley during 1956 on Cross-Flow industrial towers. Although towers tested were of many sizes and capacities, operating under varying conditions and in various parts of the country, there is one "common denominator" in all the tests—the positive performance of Marley cooling towers. Better than words, better even than written guarantees, these tests are your assurance of complete performance satisfaction when you purchase a Marley cooling tower.

The Marley Company has long pioneered the policy of "test your tower," for we believe that every purchaser is entitled—if not obligated—to know the performance of his tower in exact and authoritative terms. We also believe that every prospective purchaser is entitled to know the performance record of Marley towers, and for this reason have consistently published the results of Marley's own tower-testing program.

If you'd like to know the Marley method of measuring performance of cooling towers, regardless of make or vintage, we invite you to write for our technical publication, "TEST YOUR TOWER."

TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULTS	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	Degrees Cold Water Temp.	Percent Capacity
1	Generating Station—North Central	49,200	100.8°	85°	74°	+.26°	+2.3%
2	Generating Station—Southwest	28,000	99.5°	83°	74°	+.15°	+1.5%
3	Chemical Plant—East Coast	33,000	105°	86°	81°	+.43°	+12.7%
4	Generating Station—Mid-West	62,400	107.5°	90°	76°	+.02°	+.13%
★5	Petrochemical Plant—Mid-West	10,000	105°	83°	76°	—.25°	—2.14%
6	Petroleum Refinery—Mid-West	8,500	120°	85°	76°	+.15°	+1.35%
7	Generating Station—Mid-West	26,000	110°	91°	75°	+.70°	+3.4%
★8	Petroleum Refinery—Gulf Coast	21,000	113°	90°	80°	—.45°	—2.85%
9	Petrochemical Plant—Gulf Coast	6,000	105°	85°	80°	+.06°	+.69%
10	Petrochemical Plant—East Central	21,000	120°	85°	73°	—.2°	—1.5%
11	Generating Station—Southwest	38,700	93°	78.5°	65°	—.4°	—2.15%
★12	Generating Station—North Central	7,180	101°	87°	74°	+.1°	+.77%
13	Generating Station—East Coast	26,400	96°	86°	79°	+.30°	+4.17%
14	Petroleum Refinery—Mid-West	8,000	120°	84°	74°	+.70°	+6.4%

★ Tested in accordance with Cooling Tower Institute test procedure ATP-105 and observed by CTI representative.

FOR YOUR FREE COPY, MARK AND MAIL THE COUPON TODAY

MARLEY

The Marley Company

Kansas City, Missouri

228

Technical Services Dept.,
The Marley Company
222 W. Gregory Blvd.
Kansas City, Mo.

Please send me a copy of your brochure, "TEST YOUR TOWER."

Name.....

Firm.....

Address.....

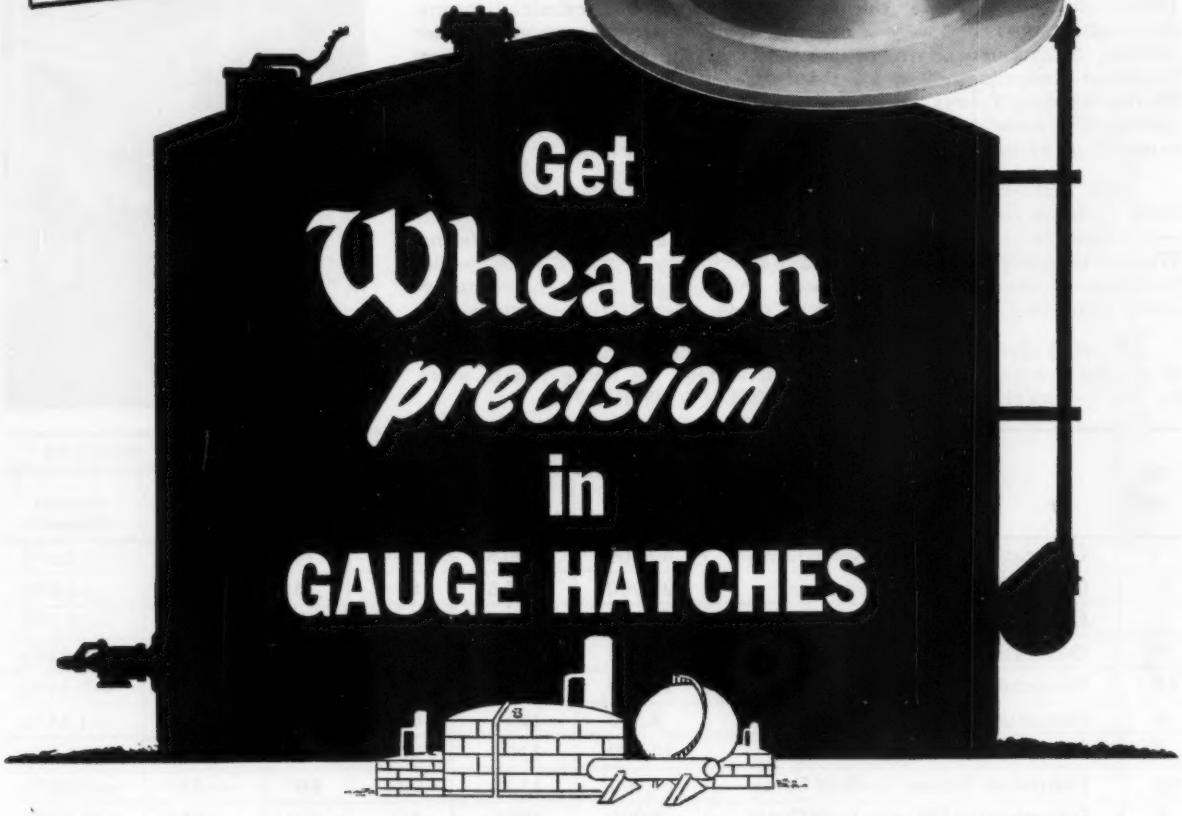
City..... State.....

For more data on advertised products, use Readers' Service Cards, last page.

CUT VAPOR LOSSES!

Wheaton T-1700 Gauge Hatch

Get Wheaton *precision* in GAUGE HATCHES



With Wheaton Gauge Hatches you get vapor-tight seating — a dependable way to reduce evaporation losses in cone roof, and low-pressurized storage tanks.

Positive tightness is assured by a resilient seal in a cast iron cover, and a non-corrosive bronze seat in the steel base. The cover closes automatically, and the impact of sudden closing is cushioned by the resilient cover seal. Units are available in T-1705 lock-down and T-1710 hand operated types, as well as T-1720S all-aluminum construction.

Get Wheaton *precision* in gauge hatches and other tank fittings — backed by 65 years of experience in the development of petroleum and chemical equipment. Send for Catalog No. 66, which illustrates and describes the complete line of Wheaton Tank Fittings.

WHEATON BRASS WORKS, UNION, N. J.

Manufacturers of Loading Arm Assemblies, Swing Joints, Loading Valves, Tank Fittings and Truck Tank Equipment

EMCO LIMITED, LONDON, CANADA

EMCO BRASS MFG. CO., LIMITED, WESTWOOD, MARGATE, KENT, ENGLAND

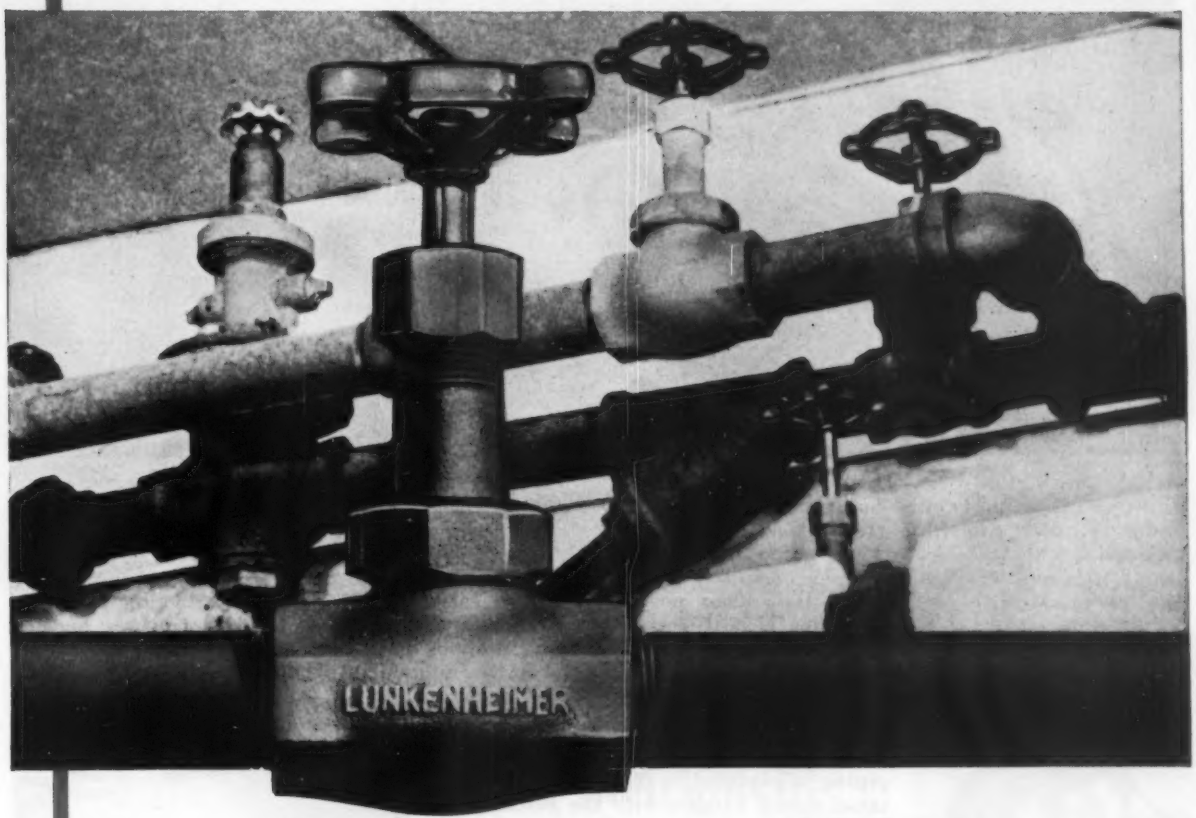
Manufacturing licensees in Germany, Sweden, France, Brazil, Australia

Tank Fittings by Wheaton

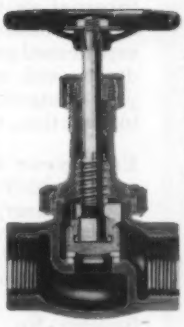
the best by every standard

Don't let LOW-QUALITY drain away YOUR *Maintenance* DOLLARS

The cost of a LUNKENHEIMER VALVE
Gets smaller...
and smaller...
and smaller...
with each passing year of dependable service.



The price you pay for the average valve represents only a fraction of its total cost. Every time a valve requires repair, more and more of your precious maintenance dollars are drained away. With today's high labor costs, it takes only one or two repair jobs to spiral maintenance expense up to a point many times higher than the original price of the valve. That's why it always pays to install the best valves your money can buy. When you insist on the extra margin of good workmanship and quality materials that go into Lunkenheimer Valves, you get your investment back many times over in trouble-free, maintenance-free service. The Lunkenheimer Company, Cincinnati 14, Ohio.



There's a cost-minded Lunkenheimer Distributor in your area. Let him show you how Lunkenheimer quality can contribute to valve maintenance savings in your plant. And be sure to check the amazing performance records of LQ600, with patented Brinalloy® seats and discs.

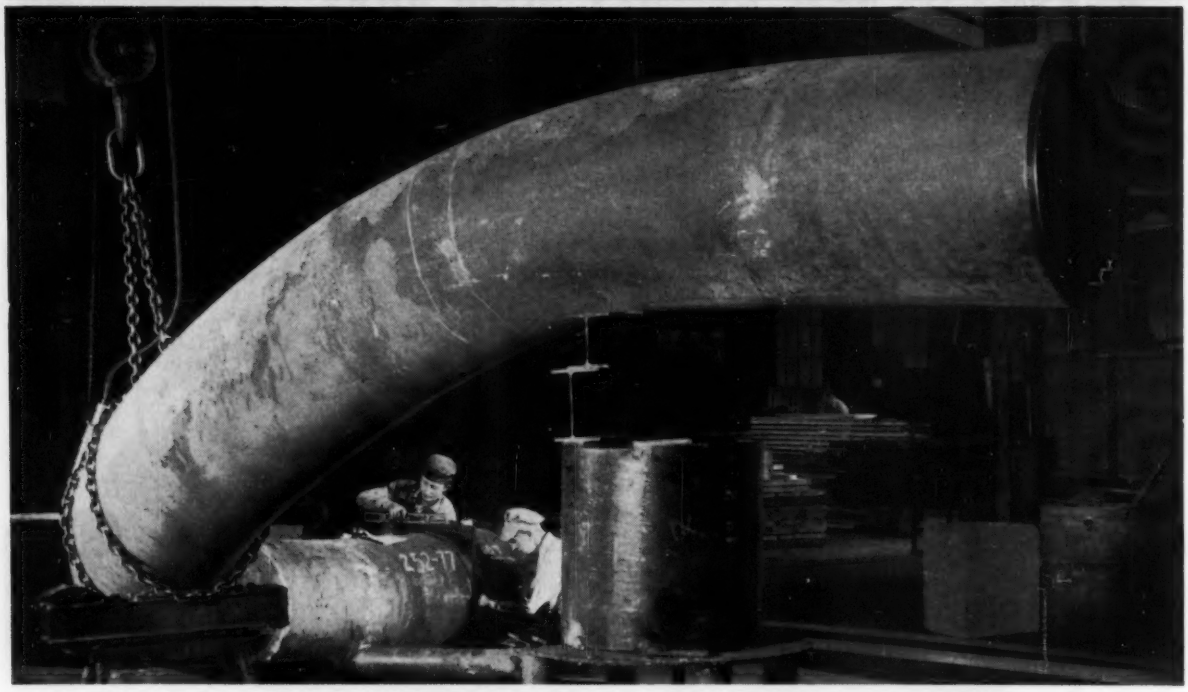
L-357-18

- BRONZE
- IRON
- STEEL
- PVC

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES

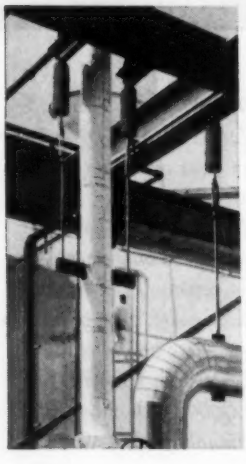
For more data on advertised products, use Readers' Service Cards, last page.

BLAW-KNOX has what it takes—to provide these products and services



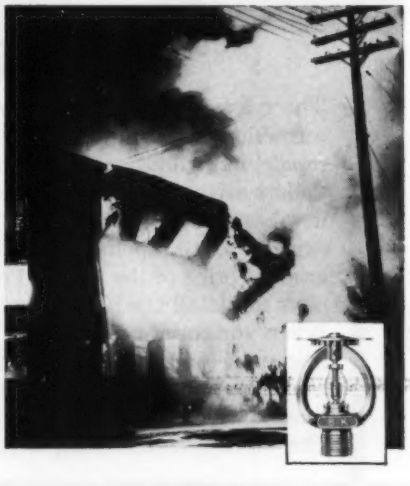
Large chrome moly pipe being readied for shipment to new generating station. Making a right angle bend followed by a 24 degree, 18 foot bend in this heavy 27½ inch chrome moly pipe required all the skill and modern facilities of the Blaw-Knox power piping shop. Before shipment, piping is heat-treated and ultrasonically tested with a radar-type device for detection of any defects.

A new Blaw-Knox "6 x 6" Flexibility Matrix Method of computing stresses in power piping systems is now available to consulting engineers, companies, and individuals responsible for the design of power piping systems. By the use of an electronic computer this method cuts calculating time from months to a day; assures full accuracy to six significant figures; and has no limitations on the complexity of the system. Write for further information about our new "6 x 6" Flexibility Matrix Method.



Two-way control over movement of piping is provided by Blaw-Knox functional spring hangers with the patented internal swivel action—shown in this modern outdoor generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. To get full information, write for Catalog No. 54.

Each year serious fire strikes one out of every seven manufacturing firms in this country. Be safe. Let a Blaw-Knox fire-protection engineer study your needs—and explain how you can pay for the system on our lease or deferred payment plan. To get more information send for Bulletin No. 2426—"Fire Can Destroy Your Business."



BLAW-KNOX

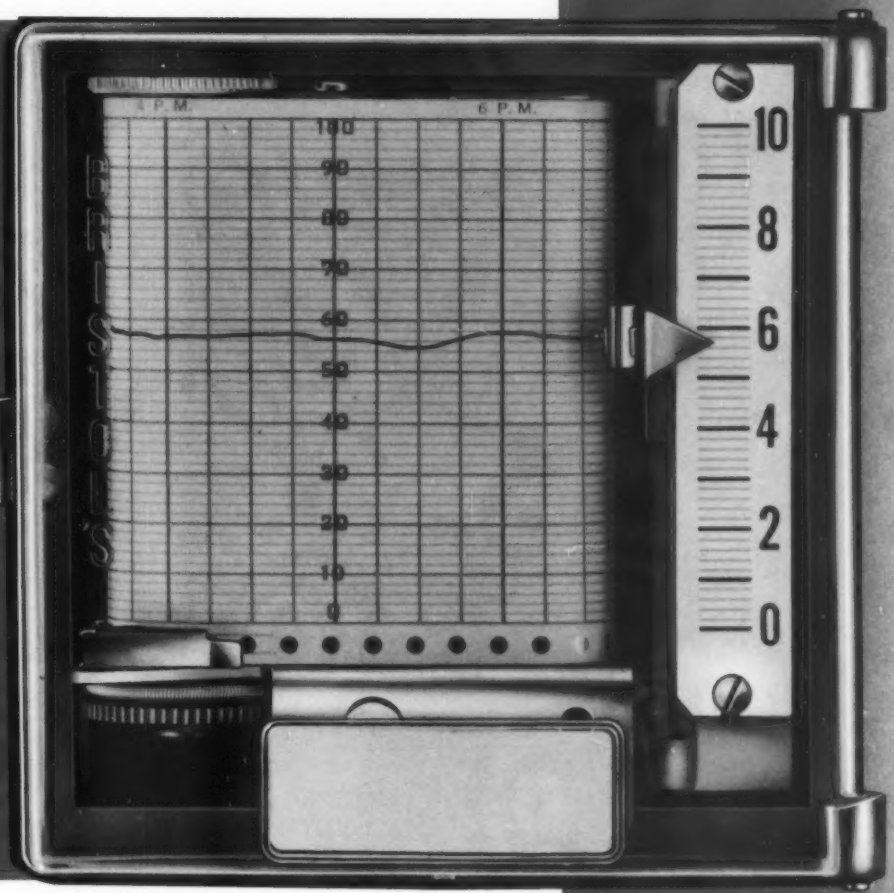
BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures . . . complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators . . . complete line of automatic sprinkler systems for standard and special hazards

Another BRISTOL First...



ACTUAL SIZE.
Only 5" x 5⅛", mounts on 6½" centers!

First true motor-driven self-balancing electronic instrument in miniature size!

USES 3-INCH CHART, HAS FULL PLUG-IN FLEXIBILITY!

It's the new Bristol Series 663 Miniature Electronic Dynamaster* Instrument—now available in both indicating and recording models.

No delicate, low-torque galvanometer-type drive unit in this instrument! *The 663 employs motor-driven slidewire self-balancing — the same principle that's been time-proved for superlative accuracy and dependability in full-size Dynamaster instruments.* All in a panel space only 5" x 5⅛"!

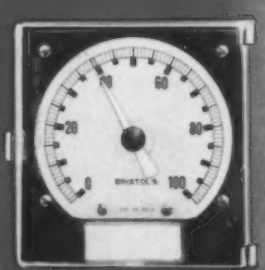
With this advance, Bristol steps ahead on two fronts:

1. Bristol now offers the widest selection of miniature plug-in instruments on the market — electronic, pneumatic, and telemetering (all with the same panel cutout) — you can get them all from Bristol.

2. Bristol becomes the first manufacturer to offer both full-size and miniature instruments in a full line. Your instrument problems get unbiased recommendations from Bristol — every time!

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

*T.M. Reg. U.S. Pat. Off.



SAME INSTRUMENT
also made as an indicator.
See next page.

Turn the page
for features on this exciting instrument development.

CHECK These Features of the new 663 DYNAMASTER... most of them found on no other miniature electronic instrument!

1. **True motor-driven self-balancing operation.** Null-balance mechanism uses high-torque, two-phase motor, *not* galvanometer-type drive unit.

2. **True plug-in chassis.** You can interchange chassis in seconds; thus, you simplify maintenance, remove overhaul to shop where it belongs. Or, you can change from recorder to indicator (or vice versa) just as quickly.

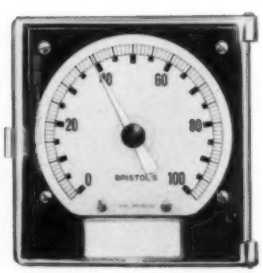
3. **High accuracy.** ½% of scale — twice as accurate as ordinary miniature electronic instruments.

4. **High-torque gradient and low dead band (0.15%).** Plenty of torque for operating alarm contacts, re-transmitting slidewires, and electric control contacts.

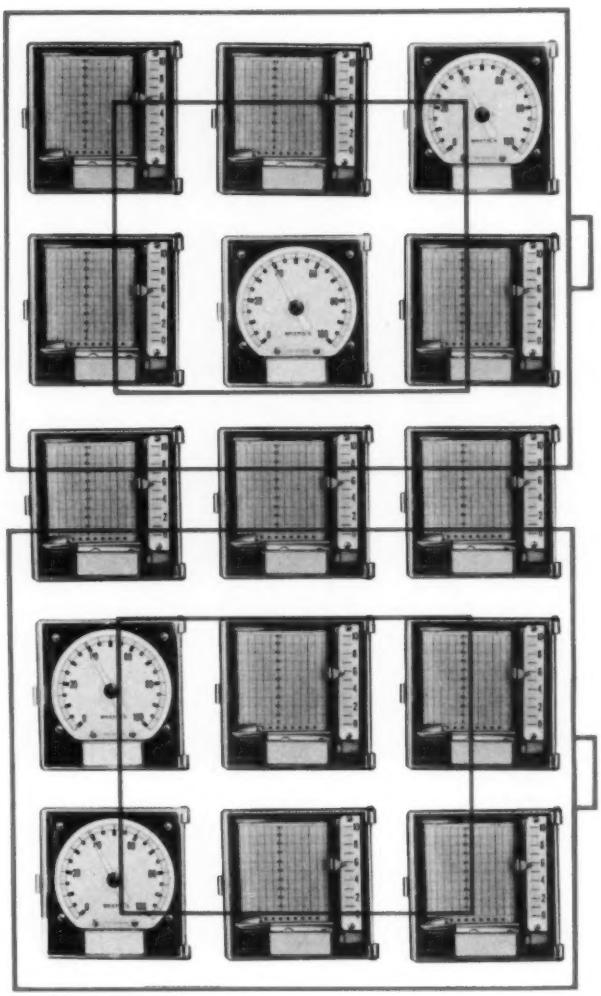
5. **Field-interchangeable range cards,** easily accessible without special tools or skill, make instrument versatile in application.

And last but not least, the new Series 663 Dynamaster instruments give you all the features that have made Bristol a by-word among instrument men. For example; building block construction and completely interchangeable parts speed servicing. Human engineered dials and charts make reading easy, accurate.

Write for the complete story on the miniature Bristol Series 663 Electronic Dynamaster instruments. And remember, for either electronic or pneumatic graphic-panel-type instruments, Bristol has the widest line on the market. The Bristol Company, Waterbury 20, Conn.



NEW INDICATING MODEL in the Series 663 is completely interchangeable with recorder of similar characteristics. Takes just 10 seconds to remove recorder and plug-in indicator, or vice versa.

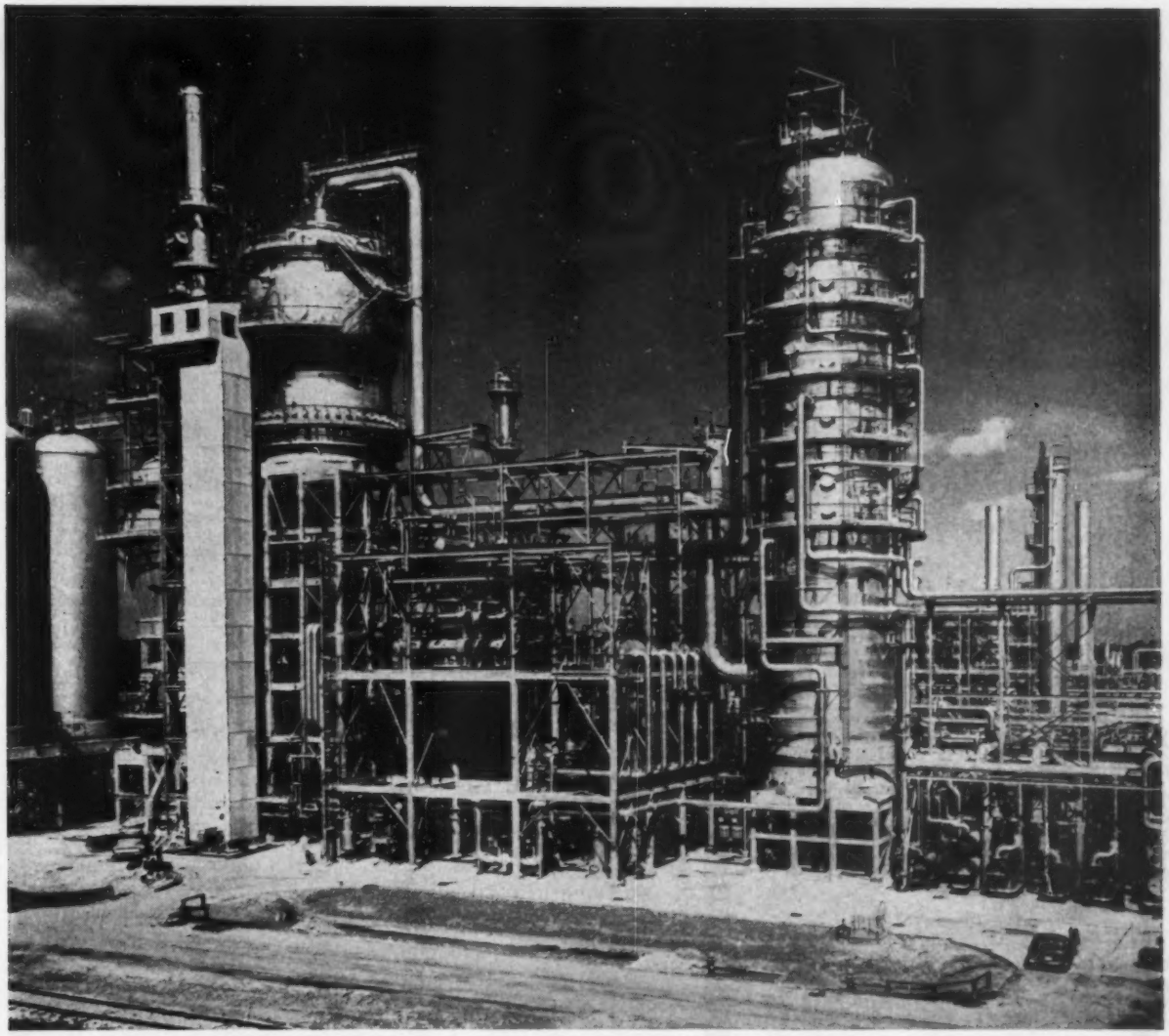


Now you can mount 15 miniature electronic instruments in space taken by 2 conventional electronic instruments (shown by red outline). Both give equal performance. New Bristol Series 663 recorders and indicators are full-size electronic instruments in everything except actual physical dimensions; are the only 3-inch chart electronic instruments using true motor-driven self-balancing mechanism.

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

*T.M. Reg. U.S. Pat. Off.



Cat cracking units like this one at Shell Oil Company's Norco, La. Refinery, use industrial concretes made with Lumnite cement to line and insulate the regenerator and stack, line the reactor cone and most of the risers and standpipes.

For better refinery performance . . . industrial concretes made with Atlas LUMNITE*

- Industrial concretes made with Lumnite and suitable aggregates resist heat, resist corrosion, and insulate.
- Production loss due to installation or repairs is minimized because placement is fast and easy. Service strength is reached within 24 hours.
- Service life of installations is extended.

For maximum convenience, use Lumnite-made castables. These are pre-mixed, ready for use, and are made and distributed by leading manufacturers of refractories. For more information, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

UNIVERSAL ATLAS CEMENTS

USS

* "LUMNITE" is the registered trademark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

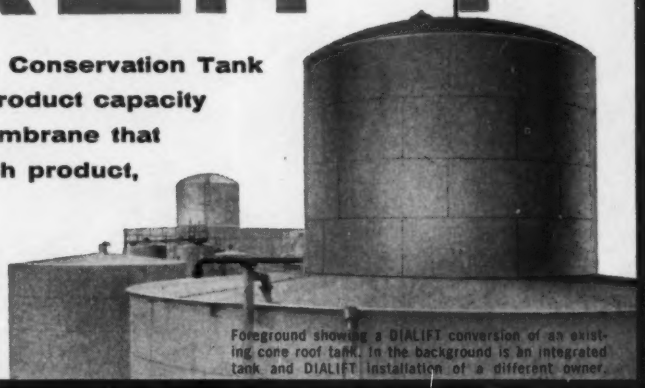
L-144

UNIVERSAL ATLAS CEMENT COMPANY—member of the industrial family that serves the nation—**UNITED STATES STEEL**

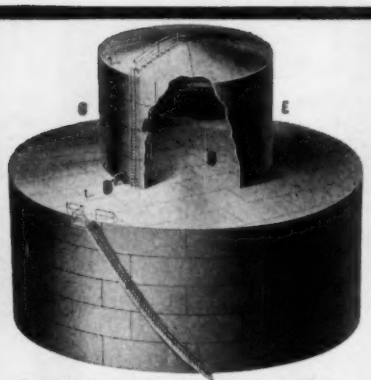
OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

The HAMMOND DIALIFT

The ONLY membrane type Conservation Tank with full-rated vapor and product capacity AT ALL TIMES, with a membrane that cannot come in contact with product, vapor space that can be isolated for inspection and maintenance without taking product storage tank out of service.



Foreground showing a DIALIFT conversion of an existing cone roof tank. In the background is an integrated tank and DIALIFT installation of a different owner.



Principle of the Hammond Dialift

- **A— DIALIFT DIAPHRAGM rises and falls to accommodate expanding and contracting vapor.**
- **B— Vapor passes to and from tank and DIALIFT through simple elbow connection.**
- **C— DIALIFT and tank have full-rated capacity.**
- **D— Membrane can't come in contact with product.**
- **E— DIALIFT can be isolated for maintenance and inspection, product tank stays in service.**

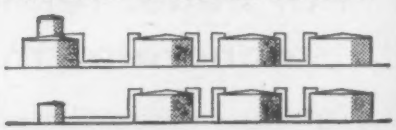
The most efficient and economical vapor conservation system for new or old tanks.

THE HAMMOND DIALIFT consists of a gas-tight Vulcalock membrane attached to the inside periphery of a cylindrical metal housing to become a "breathing" apparatus to accommodate the expanding and contracting vapor as developed in product storage tanks. The DIALIFT can be used as a single conservation unit by being attached to the roof of a product storage tank or as a central "breathing" system by being manifolded to a number of product storage tanks. There are two forms of installation: —Ground type manifolded to a number of tanks to form a conservation system and integrated type whereby the DIALIFT is attached to the roof of a product tank for vapor conservation for one or a number of tanks.

The DIALIFT is completely isolated from the product storage tank. Vapor passes between the tank and DIALIFT through a vaporline connection. It is easy to convert old cone roof tanks to efficient vapor-saving DIALIFT installations by attaching a DIALIFT housing with membrane to the roof of the old tank and connecting the vaporline between the tank and DIALIFT.

New or converted DIALIFT tank, inter-connected with cone-roof tanks, becomes central "breathing" unit.

DIALIFT GROUND UNIT serves as central "breathing" apparatus of multi-tank conservation system.



The HAMMOND dialift eliminates breathing loss and reduces filling loss

Other HAMMOND Bulletins describe these individual types of tanks: Floating Roof, Diaflote,* Vaporlift, Field Erected Underground, Elevated Water Tanks and Standpipes, Low Pressure, Bulk Storage.

Write for Dialift Catalog 55DL

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

BOSTON 10, MASS. • NEW YORK 20, N. Y. • CINCINNATI 2, OHIO • CHICAGO 3, ILL. • WARREN, PA. BRISTOL, PA. • ARLINGTON, VA. • GREENVILLE, S. C. • BIRMINGHAM, ALA. • SAGINAW, MICH. SAPULPA, OKLA. • PROVO, UTAH • CASPER, WYO. • LOS ANGELES 57, CALIF. • HAVANA • MEXICO CITY "TIPSA," BUENOS AIRES • CAIRO, EGYPT • PORT-AU-PRINCE, HAITI • LIMA, PERU

Licensees: CALIFORNIA, CANADA, ENGLAND, BELGIUM, GERMANY, ITALY, FRANCE, JAPAN

HOW IR REFINERY PUMPS

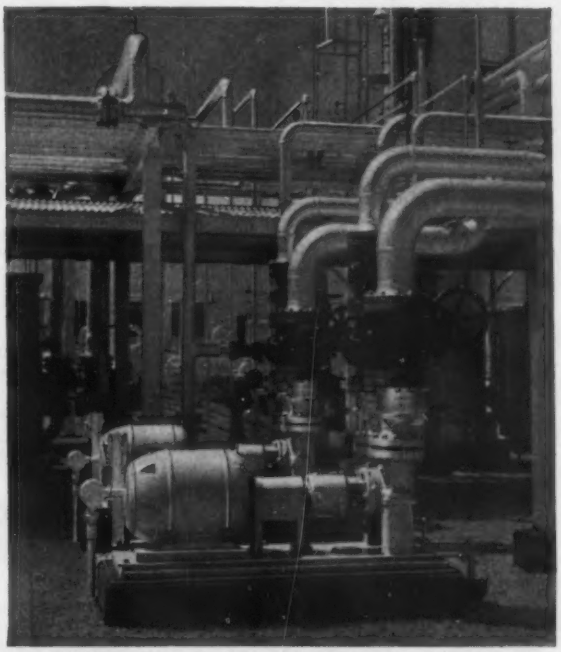
CUT DOWN-TIME • SAVE MAINTENANCE

Easy maintenance and less of it. These are important considerations in the design of every Ingersoll-Rand Refinery Pump. Here are some of the features that keep these pumps *on the job* longer, cut down-time and save maintenance costs.

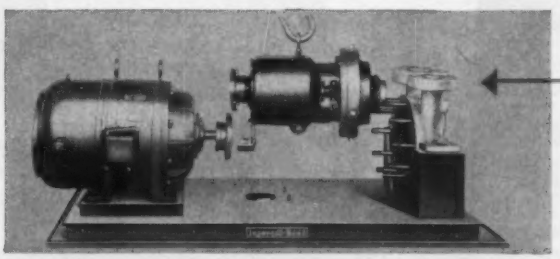
IMPELLER is carefully balanced for freedom from vibration. Made of bronze, iron or steel, for maximum service life under operating conditions. Impeller attached to shaft with pin-locked cap screw—can't work loose.

CASING is heavy-walled to provide corrosion allowance with conservative safety factor at maximum working pressure. Centerline support and water cooled stuffing box for hot liquid service to 800°F.

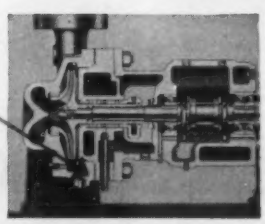
CASING LOCATING PIN, centered under casing, assures perfect pump alignment during high-temperature operation.



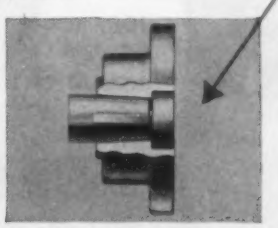
Two 1½" SFL pumps on reflux service at a natural gasoline plant.



Class SFL pump with coupling spacer removed, showing ease of disassembling pump unit.



Cross section of SFL pump



Ground, tapered coupling fit

SHAFT, of heat-treated carbon steel or stainless-steel, is fully ground and polished—held to close tolerances over entire length for perfect fit of replacement parts.

STUFFING BOX is deep enough to allow packing to be arranged to suit the application. Holds 8-10 rings, packed solid. Mechanical Shaft Seals can also be supplied.

SPLIT-TYPE GLAND is easy to remove from shaft. Smothering liquid can be circulated through gland when hazardous liquids are handled.

SPACER COUPLING permits quick, easy removal of entire pumping assembly without disturbing piping or driver.

TAPERED COUPLING FIT, with key and lock nut, eliminates need for shrink fit and permits easy removal or replacement.

For the complete story on I-R refinery and process pumps, send for your copy of Bulletin 7094B.

Ingersoll-Rand

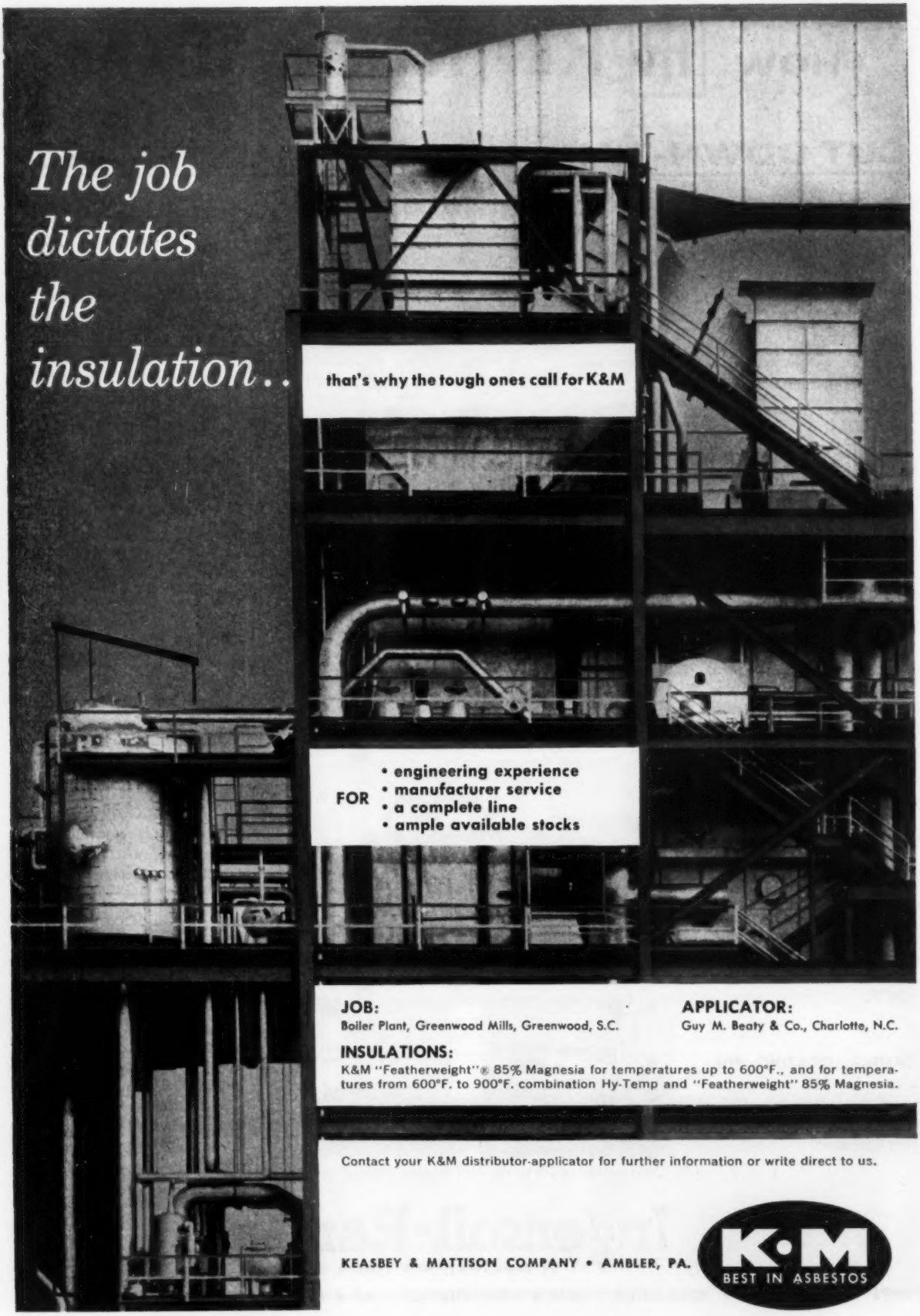
10-417 11 BROADWAY, NEW YORK 4, N.Y.

PUMPS • CONDENSERS • ROCK DRILLS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS • VACUUM EQUIPMENT

The job dictates the insulation..

that's why the tough ones call for K&M

FOR
- **engineering experience**
- **manufacturer service**
- **a complete line**
- **ample available stocks**



JOB:
Boiler Plant, Greenwood Mills, Greenwood, S.C.

APPLICATOR:
Guy M. Beaty & Co., Charlotte, N.C.

INSULATIONS:
K&M "Featherweight"® 85% Magnesia for temperatures up to 600°F., and for temperatures from 600°F. to 900°F. combination Hy-Temp and "Featherweight" 85% Magnesia.

Contact your K&M distributor-applicator for further information or write direct to us.

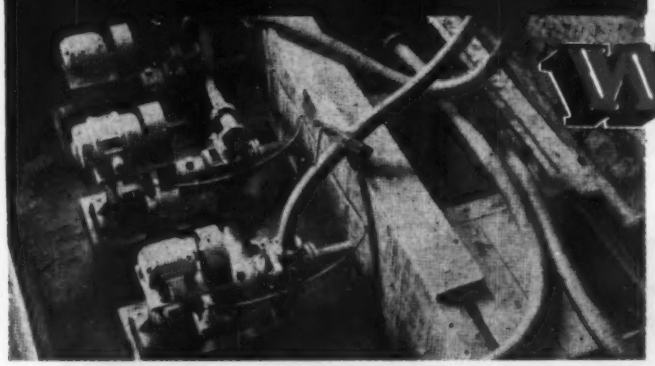
KEASBEY & MATTISON COMPANY • AMBLER, PA.

K·M BEST IN ASBESTOS

URANIUM

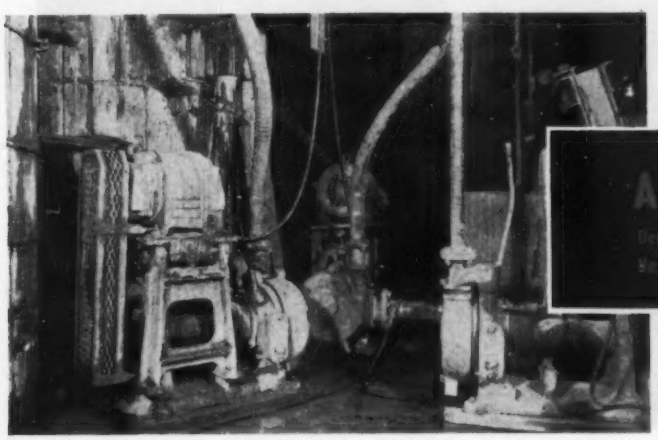
produced at lower costs with

WILFLEY PUMPS



WILFLEY ACID PUMPS receiving vanadium and uranium leach liquors from leach tanks and pumping them to various treatment tanks.

WILFLEY SAND PUMPS receiving the classifier overflow and pumping the material to the sand slime separation circuit.



Crucial production steps performed in today's uranium processing plants call for rugged, highly-efficient pumps. Many of these plants use Wilfley Model "K" Sand Pumps and Wilfley Model "AF" Acid Pumps . . . companions in economical, trouble-free operation.

Individual Engineering on Every Application.

Write, wire or phone for complete details.

A. R. Wilfley and Sons, Inc.

Denver, Colorado, U. S. A.

New York Office: 122 East 42nd Street, N.Y. City 17, New York

WILFLEY ACID PUMPS

"COMPANIONS IN ECONOMICAL OPERATION"

WILFLEY SAND PUMPS

For more data on advertised products, use Readers' Service Cards, last page.

GASOLINE KEEPS ITS POWER IN STORAGE WHEN IT CONTAINS

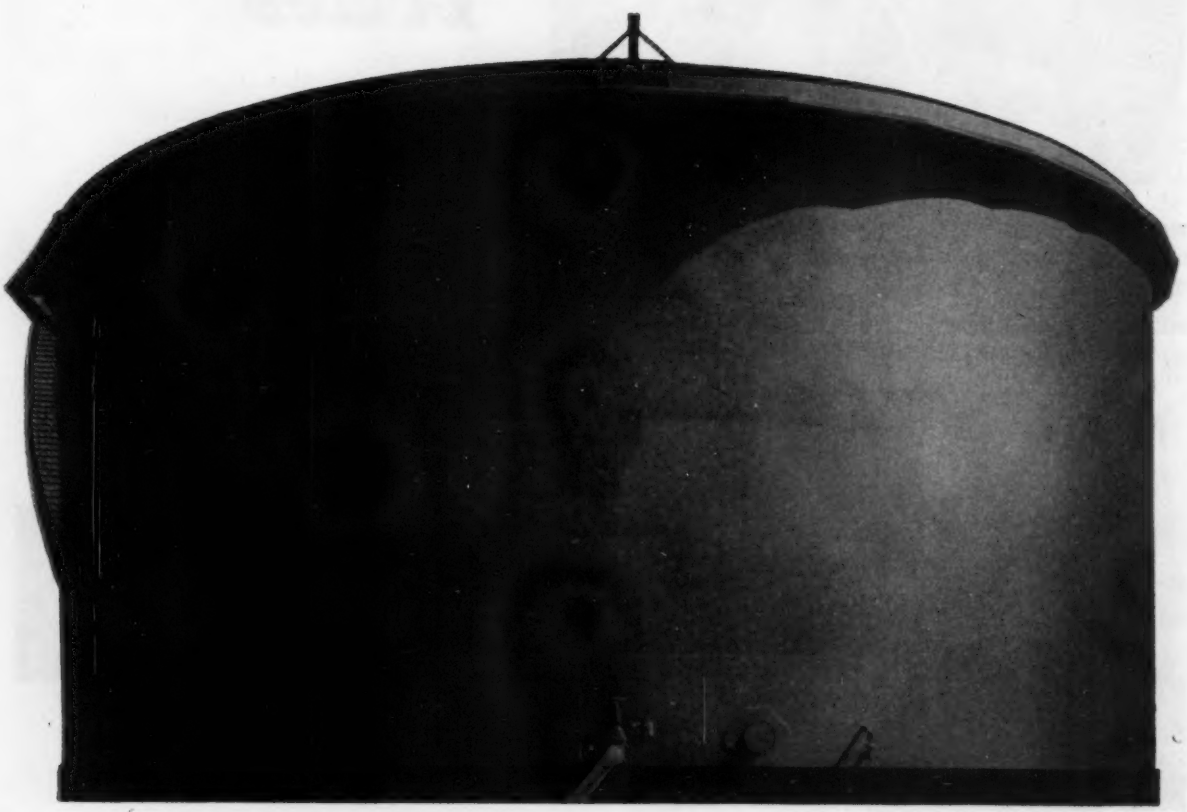
Tenamene

EASTMAN GASOLINE ADDITIVES

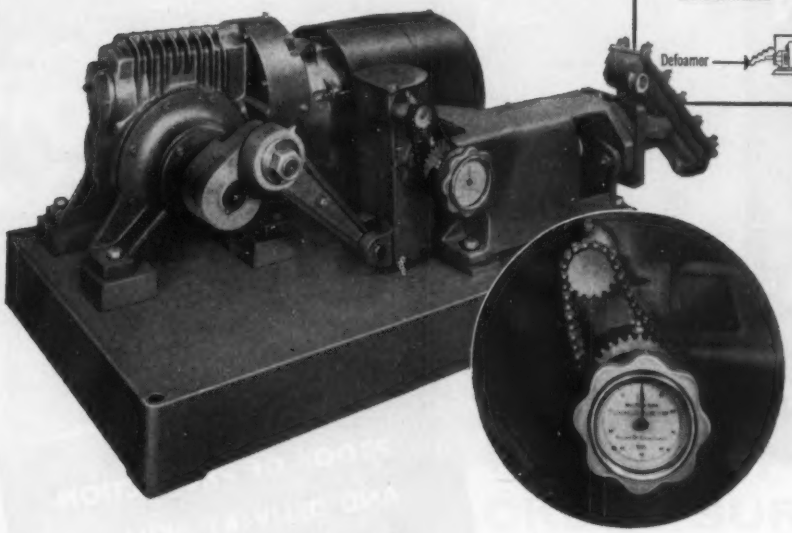
No matter how superior a gasoline you produce, the formation of gums in storage can rob it of its power. To protect the performance of your gasolines—to protect your sales—rely on Tenamene gum-inhibiting additives. Rely, too, on the interested technical service of Eastman petroleum specialists, ready to help solve your refinery inhibitor problems on the spot.

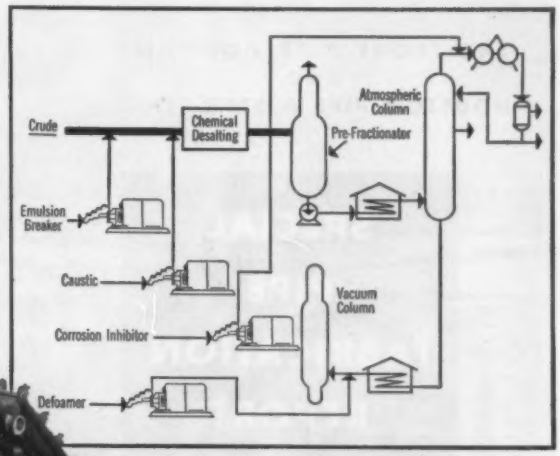
For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *subsidiary of Eastman Kodak Company,* KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc. Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.



Controlled Volume Pump with dial adjustment which changes stroke length while pump is operating. Typical applications shown (right) include the metering of corrosion inhibitors, defoamers, and desalting chemicals.





Efficient chemical treatment safeguards quality of your products

Controlled Volume Pumps accurately meter acids, caustics, inhibitors and additives against a head

Spot these positive-displacement metering pumps throughout your process, to handle oxidation and corrosion inhibitors . . . octane appreciators . . . sulfuric acid or water treating chemicals . . . emulsion breakers . . . defoamers. *Wherever* you use Milton Roy Controlled Volume Pumps, you'll enjoy savings in chemical costs, while safeguarding product quality.

What's more, the simplicity and dependability of these pumps reduce installation cost, minimize shutdown time and maintenance.

Write for detailed information on Controlled Volume Pumps as they relate to your particular application.

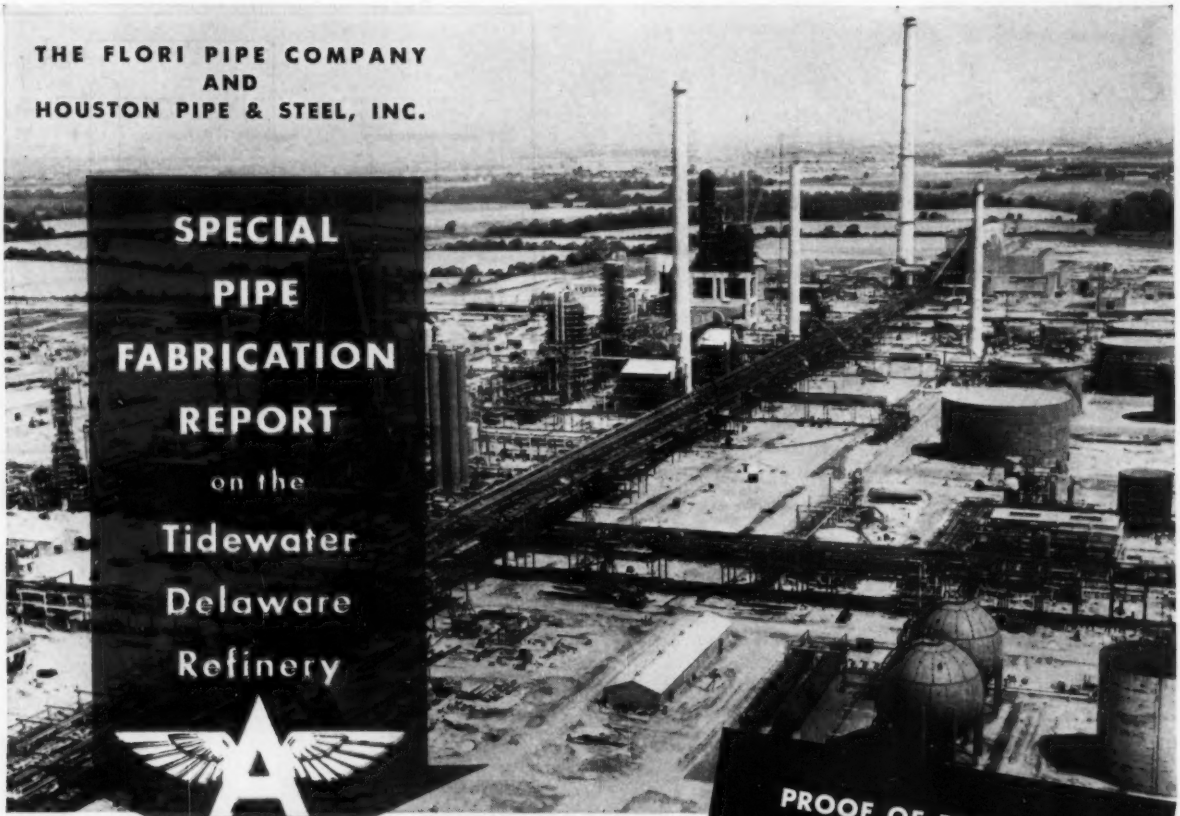
Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, Australia, Africa.

For more data on advertised products, use Readers' Service Cards, last page.

THE FLORI PIPE COMPANY
AND
HOUSTON PIPE & STEEL, INC.



PROOF OF PRODUCTION AND DELIVERY SKILL APPARENT IN HUGE DELAWARE REFINERY OF TIDEWATER OIL CO.

FLORI completes reported largest alloy pipe fabricating project ever undertaken...

The Flori-Houston fabrication of substantially all alloy piping for Tidewater Oil Company's gigantic Delaware Refinery constitutes the reported largest alloy pipe fabricating project ever undertaken. Situated 15 miles south of Wilmington, Delaware, on a 5,000 acre site, it is the largest petroleum refinery ever built at one time.

Into this gigantic refinery went incredible quantities of fabricated pipe of numerous sizes and various metallurgical content. This project required almost 250 miles of piping. Flori-Houston delivered more than 1500 tons of fabricated alloy piping.

Approximately 1400 separate units, averaging more than a ton apiece in weight and needing more than 20,000 blueprints, were fabricated. Operational requirements in the refinery included temperature ranges to 950 F. and pressure ranges to 1350 lbs. per sq. in. To meet these requirements Flori fabricated thirteen different alloys, including nickel, monel, inconel, and incoloy.

A truly amazing feature of the project was the tight quality control program required throughout. Specifications for the job required 100% penetration—without the use of backing rings—for all welds.

This is just more proof that the Flori-Houston skill and experience can handle any fabricating job expertly, efficiently and economically.

SEE HOW THIS COMPETITIVE SERVICE AND PRODUCTION CAN WORK FOR YOU.

SEND FOR FREE BROCHURE...
This illustrated 16-page brochure shows every stage of the new Flori-Houston operation.

GENERAL OFFICE
THE FLORI PIPE CO.
601 E. RED BUD • ST. LOUIS 15, MISSOURI

HOUSTON OFFICE
HOUSTON PIPE & STEEL, INC.
P. O. BOX 2 • HOUSTON 1, TEXAS

subsidiaries of
SPARTON CORPORATION

Color Coat No. 261 adds lasting beauty to Insul-Mastic Gilsonite protective coatings.

NEW INSUL-MASTIC COLOR COAT No. 261 COVERS BLACKEST SURFACES . . .

solves these difficult finish problems . . .

ADHESION Color Coat No. 261 is the one finish that will stick to and cover black bituminous mastic coatings, old or new . . . as well as concrete, brick, cinder block, porous roofing tile, asbestos shingles, stucco—and properly primed wood and metal. *Dries in approximately 30 minutes!*

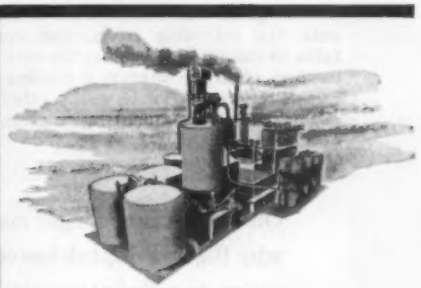
CONTRACTION EXPANSION Color Coat No. 261 leaves a tough pigmented plastic film that flexes with expansion and contraction of base material. *Ideal for color keying service lines!*

DURABILITY Color Coat No. 261 takes weather in stride, and also shows remarkable resistance to sunlight, gases, corrosive fumes, cleaning compounds and many solvents!

FRESH COLORS Color Coat No. 261 is available in Rose, Light Green, Light Blue, Light Yellow, Light Buff, Light Gray, Dark Gray and White—and in an unlimited variety of do-it-yourself colors. *Safe to store and apply!*

Think first of the coatings that last!

Insul-Mastic
CORPORATION OF AMERICA
7756 WEST 61st PLACE • SUMMIT, ILLINOIS



What Is Insul-Mastic Color Coat No. 261?

It is a modified acrylic resin dispersion combined with selected chemically inert pigments. Application is economical by conventional spray equipment, brush or roller.

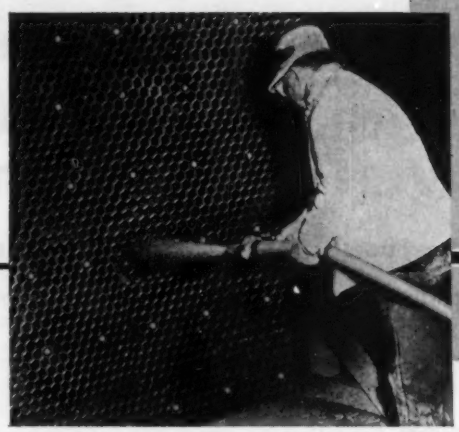
MAIL THIS COUPON TODAY TO:
INSUL-MASTIC CORPORATION OF AMERICA
7756 West 61st Place, Summit, Illinois
☐ Send Information ☐ Have Representative call
Name_____ Title_____
Company_____
Address_____
City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

ELECTRONICS and *Mud*

Notice the ear phones on his head. He is in constant voice communication with the gunnite operator—receives instructions so that exactly the right proportions of water and dry castable are used. Result: longer refractory life in refinery vessel installations.

As he "guns" the castable-water mixture onto the retaining mesh, the operator talks to the man governing the mix—telling him when the mixture is coming in too wet or too dry. Prior to walky-talky communication, hand signals were given from hundreds of feet away.



Off-stream time hinges upon the durability of the equipment in the refinery. That's why Bigelow-Liptak has concentrated so much upon improvement of castable application to refinery vessels. As a result, you'll find B-L installations are hanging up record after record for long life and consequently helping to reduce the per-barrel cost of refined products. Remember that Bigelow supplies a complete one-source service to refineries: engineering, materials and erection. Better investigate today!

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION

13300 PURITAN AVENUE, DETROIT 27, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MIAMI • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • MONTREAL • SAULT STE. MARIE, ONT. • VANCOUVER • WINNIPEG

For more data on advertised products, use Readers' Service Cards, last page.

Refractory Castables are SPECIALIZED

Which are best to use in refinery units?

Naturally, the type of refractory castable selected depends upon the specific service. B&W makes a line of specialized refractory castables which are being widely used in catalytic reformers and catalytic cracking units, as well as in furnaces, ducts and stacks. For easy reference, here are some typical applications together with the recommended B&W Refractory Castables:

APPLICATION	DESIRABLE PROPERTIES	RECOMMENDED B&W CASTABLES
Linings of catalytic reformers	Extremely low iron content, extra high strength. Extremely low iron content, plus good insulation. Low iron content, high temperature use limit.	Kaocrete LI Kaolite LI Kaocast
Lining desulphurizers	Good workability	Kaocrete B
Transfer lines and regenerators of catalytic cracking units	Extra abrasion and erosion resistance.	Kaocrete D
Heads of reactors and regenerators	Plasticity, excellent workability.	Kaocrete B
Insulating furnace floors	Good insulation, light weight	Kaolite-20 Kaolite-22
Tube sheets	Good insulation, light weight	Kaolite-20 Kaolite-22
Burner blocks	High temperature use limit, refractoriness and spalling resistance.	Kaocast
Openings where doors and other points are subject to mechanical abuse	Extra abrasion and erosion resistance	Kaocrete D
Furnace doors	Good insulation, light weight	Kaolite-20 Kaolite-22
Ducts and stacks	Good insulation, light weight	Kaolite-20

Bulletin R-35 contains additional information on B&W Refractory Castables. Send for your copy.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

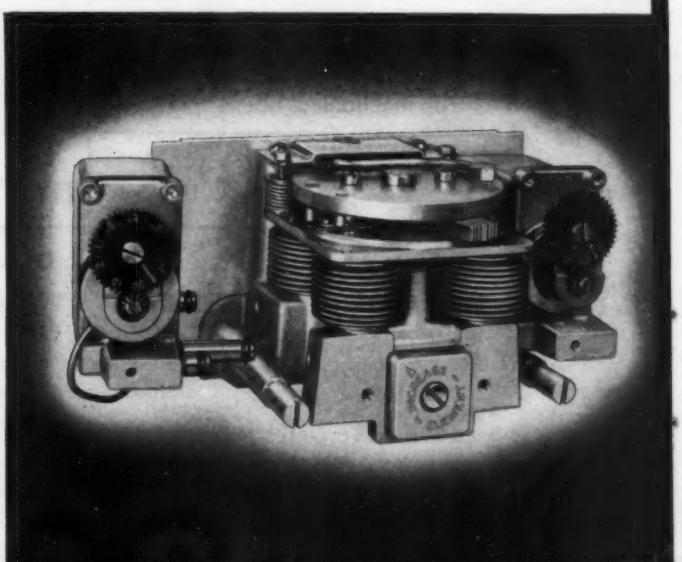
R-862

The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.



Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.

Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. The Foxboro Company, 745 Neponset Avenue, Foxboro, Mass., U.S.A.

*Reg. U.S. Pat. Off.

FOXBORO
Reg. U.S. Pat. Off.

CONSOTROL INSTRUMENTS

The Inside Story of
CHAPMAN
Motor Units

For Valves, Floorstands and Sluice Gates

The exposed view gives you the facts. On a Chapman Motor Unit there are approximately half as many parts as with any other make. This is engineering sense. The fewer the parts the fewer the headaches. The less complicated the unit the less you pay for maintenance.

This simplification in design is all on your plus side. You lose nothing in performance. In fact you get smooth accurate performance over a *longer* period of time. There's no drift. Backlash is low. And seat tightness is held at any predetermined level by precise micrometer-controlled limit switch.

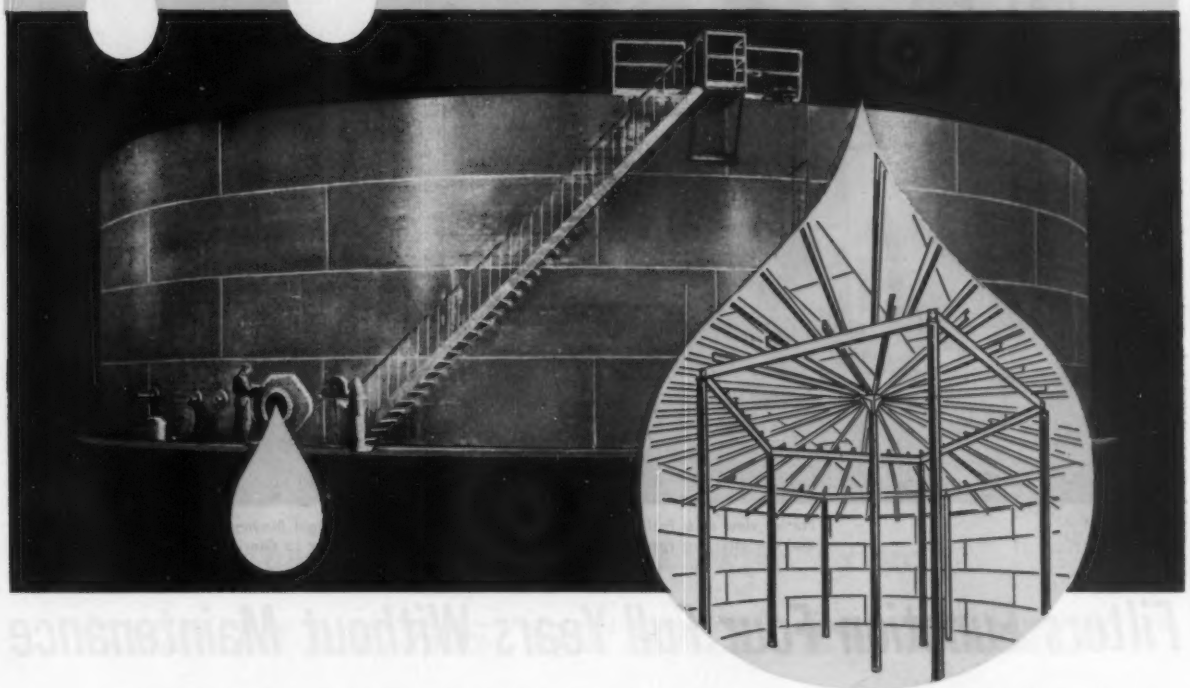
Installation is easy and economical. When used with floorstands they come completely wired at factory . . . ready for your line. They're weatherproof. They're *steam tight*. And they operate at any angle. Rugged stub-tooth gears require no grease or oil.

See our Catalog 51, now. If you've misplaced your copy write for a new one, today.

THE CHAPMAN VALVE MANUFACTURING CO.
INDIAN ORCHARD, MASSACHUSETTS

Aluminum—1st Choice for Giant Ammonium Nitrate Tank

No other corrosion-resistant metal could do the job at such low cost!



Aluminum is one of the few metals that can resist the strong corrosive action of ammonium nitrate and other chemicals. And no other metal can store chemicals as economically as aluminum.

That's why Aluminum was specified for the Mississippi River Chemical Company's newest tank for storing 83% ammonium nitrate solution. The Nooter Corporation, St. Louis, fabricated this tank—100 feet in diameter and 23 feet 2½ inches high—from 5052-H112 aluminum plate over interior structural members of 6061 aluminum.

When stored in aluminum tanks, the *stability* of ammonium nitrate is assured. And aluminum tanks give extra-long service, under constant exposure to corrosive attack, with a minimum of maintenance.

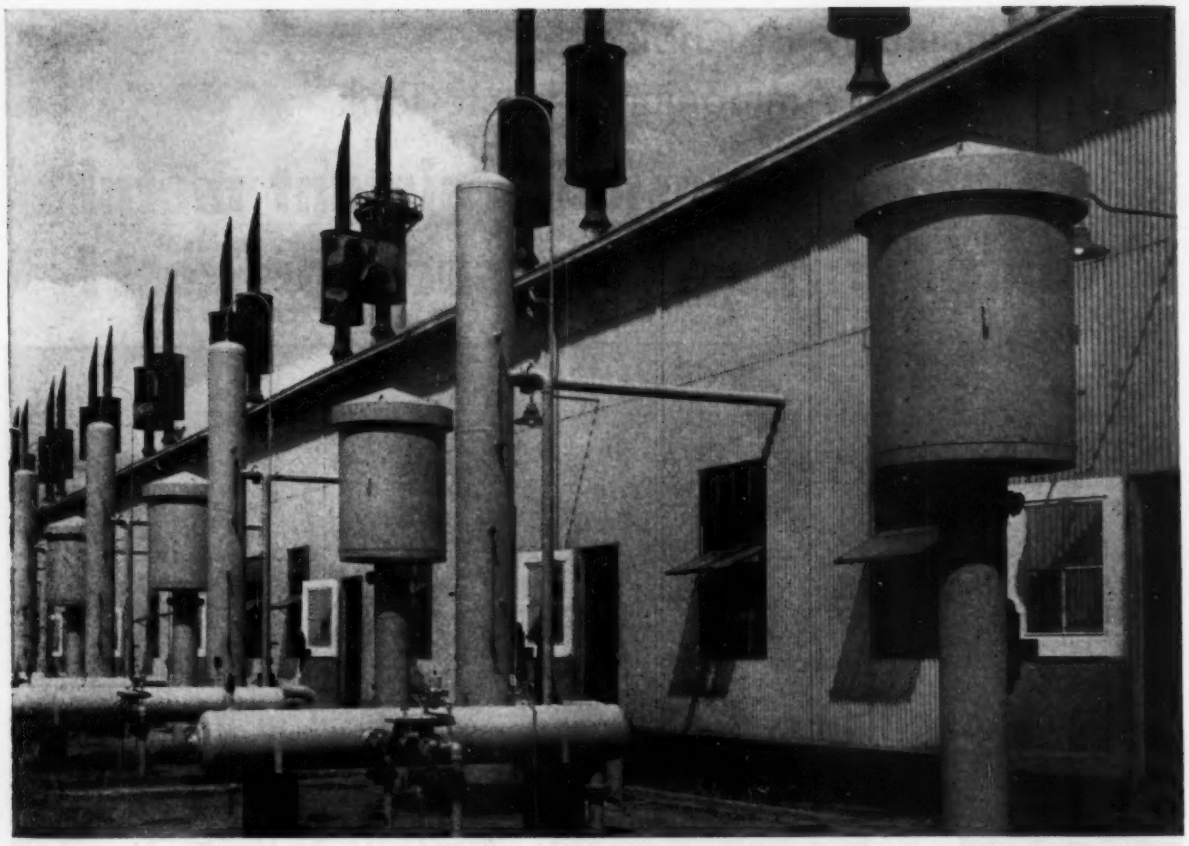
For facts and figures on other applications of aluminum in the chemical industry, see our new 16 page brochure, "Reynolds Aluminum Tanks and Vessels". To get your *free* copy, write to *Reynolds Metals Company, P. O. Box 1800-CT, Louisville 1, Ky.*

See "CIRCUS BOY", Reynolds exciting dramatic series, Sundays on NBC-TV.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

REYNOLDS ALUMINUM

For more data on advertised products, use Readers' Service Cards, last page.



Partial view of a Falfurrias, Tex., gas plant showing four of eight Staynew air-intake filters that are effecting spectacular economies in maintenance costs for La Gloria Oil and Gas Co.

Filters Function Four Full Years Without Maintenance

In 1952 the Falfurrias, Tex., gas plant of La Gloria Oil and Gas Co. substituted two Staynew air-intake filters for conventional oil-bath filters on two gas-engine-driven, natural-gas compressors.

Two and a half years later the pressure drop through the Staynew filters had increased only to where it equalled the pressure drop of an oil-bath filter *immediately after an oil change*.

Air resistance was not yet enough to warrant cleaning. Therefore, La Gloria left the filters alone for another 19 months before deciding on an overhaul.

Oil-bath filters by comparison had required an oil change every 10 months, each change calling for *60 gallons of oil* and high labor costs.

As evidence of its satisfaction with Staynew filters, the company installed four more in 1954, another pair in 1955, and an additional three in 1956 to replace the last of the oil-bath filters.

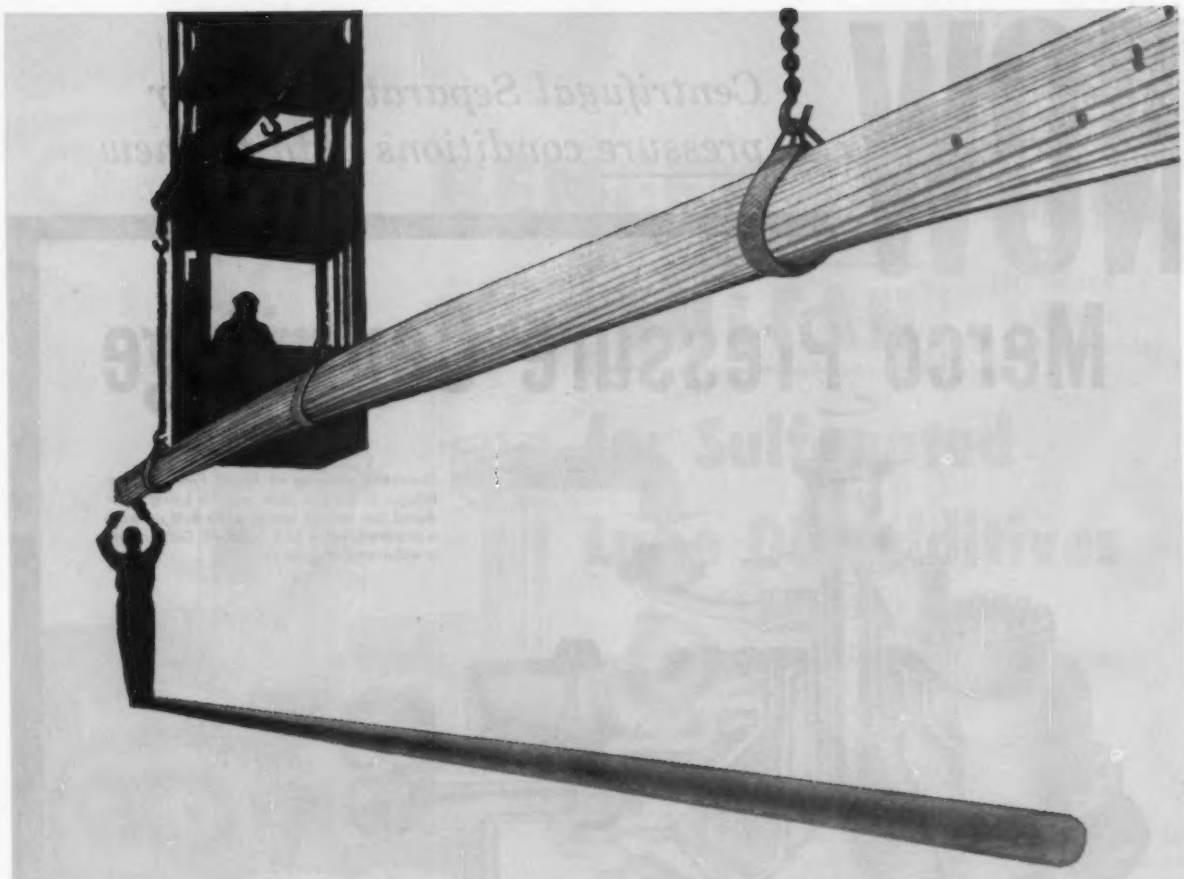
The efficiency of Dollinger Staynew filters actually increases with use. So why buy filters that require rigid maintenance schedules? Let a Dollinger representative show you how to save time and money with Staynew Intake Filters, or write for Bulletin 100. Dollinger Corporation, 47 Centre Park, Rochester 3, N. Y.

PROTECTOMOTOR U.S. PAT. OFF.

STAYNEW DOLLINGER FILTERS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

For more data on advertised products, use Readers' Service Cards, last page.



Here is the answer to your needs for **EXTRA LONG**

SEAMLESS STEEL TUBING

Pacific Tube Company can now supply you with precision, cold-drawn Seamless Steel Tubing in absolutely straight lengths up to 58 feet long. Special new equipment, including new pickling tanks 60 feet long makes this feat possible. The longest draw bench in the country helps, too!

For your protection and better tubing, new high-pressure hydrostatic testing is used.

A wide range of sizes is quickly available in many chemistries in Stainless, Seamless Carbon and Alloy Tubing... cold-drawn to your exact specifications.

If you are faced with an application or metallurgical problem, our engineering staff can be of valuable assistance... just let us know your problem.

Pacific also manufactures...
COLD-DRAWN BARS
GROUND & POLISHED SHAFTING
Precision drawn to rigid specifications from 3/16" thru 3½" in many chemistries including Ledloy Grades A & B.

Pacific
TUBE COMPANY

5710 Smithway St., Los Angeles 22, Cal.,

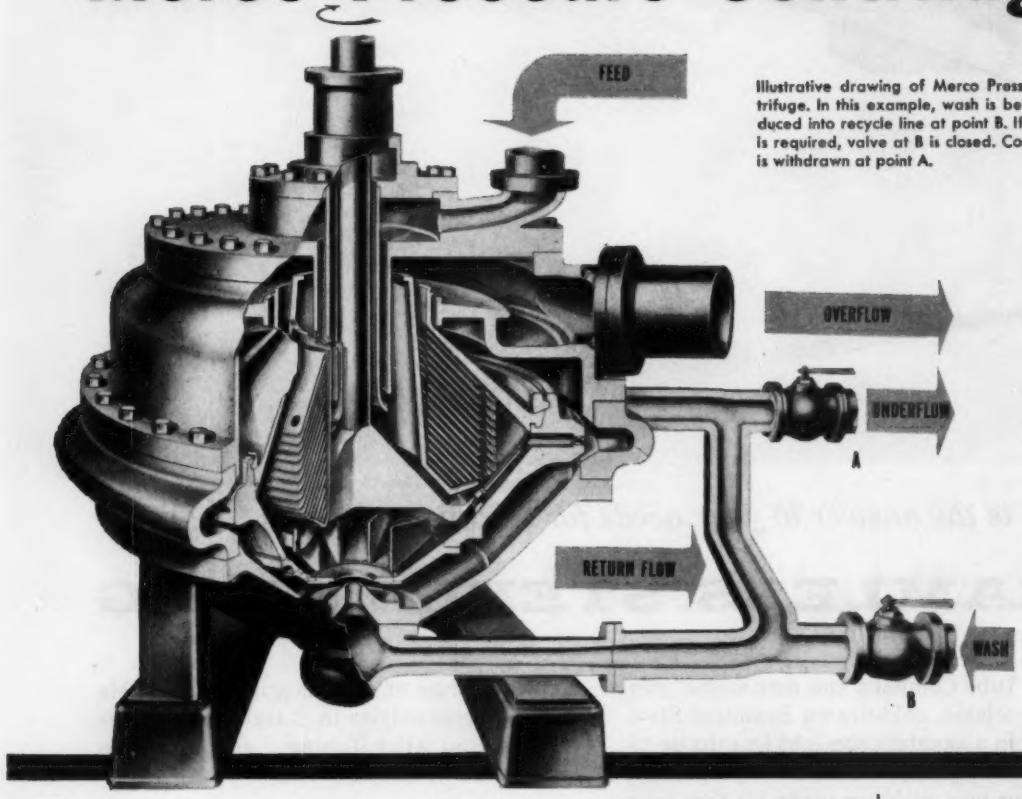
MANUFACTURERS OF SEAMLESS STEEL TUBES • BAR STOCK • GROUND & POLISHED SHAFTING

For more data on advertised products, use Readers' Service Cards, last page.

NOW

Centrifugal Separations under pressure conditions with the new

Merco Pressure Centrifuge



Illustrative drawing of Merco Pressure Centrifuge. In this example, wash is being introduced into recycle line at point B. If no wash is required, valve at B is closed. Concentrate is withdrawn at point A.

Newest development in wet processing equipment, the Merco Pressure Centrifuge is designed for all continuous centrifuging applications at pressures up to 110 psi. Key to pressure operation is a specially designed housing closure that has been exhaustively tested at pressures two to three times the guaranteed figure of 110 psi. Equally important, this new unit incorporates the unique Merco "Return Flow" principle for maximum operating flexibility. Under centrifugal forces thousands of times higher than gravity, even the smallest particles in the feed "sink" rapidly outward and are continuously expelled through fixed open nozzles in the rotor. A controlled portion is withdrawn as finished concentrate and the remainder becomes a return flow to the rotor. Wash, if desired, is introduced to the return flow line . . . clear, excess liquor overflows out the top of the unit.

If there's a step in your flowsheet involving concentration, washing, clarification, soluble recovery, or classification *under pressure*, there is a good chance that this new tool will prove useful. Bulletin No. 2600, just off the press, describes the Merco Pressure Centrifuge in detail. For your copy, write Dorr-Oliver Incorporated, Stamford, Conn.

Merco T.M. Reg. U. S. Pat. Off.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U.S.A.

Check these positive advantages . . .

Pressure Operation — Concentration, washing, clarification, soluble recovery or classification can be carried out under pressure.

No Solids Build-up — All solids entering the unit are continuously discharged. Return flow flushes solid material at periphery of rotor.

No Nozzle Clogging — Return flow principle permits nozzle flow 2 to 10 times as great as the underflow actually withdrawn. Merco nozzles will discharge particles as large as 1/32 inch.

Practical Design — All separating conditions are controlled externally. The unit is equipped with a sturdy housing which has been X-rayed and hydrostatically tested.

For more data on advertised products, use Readers' Service Cards, last page.

BENEFITS You can get with SULFAN® (Stabilized Sulfuric Anhydride) for Sulfonated Lube Oil Additives

and other

Emulsifying and Demulsifying Agents

BENEFIT No. 1 **Increase Yields**

Because of the extremely reactive nature of SULFAN, higher molecular weight compounds can be sulfonated to produce desirable oil soluble sulfonates. Treatment with Sulfuric Acid or 20% Oleum leaves these compounds unreacted.

BENEFIT No. 2 **Eliminate Waste Acid Problem**

Since water is not formed when SULFAN is used for sulfonation, the waste acid problem inherent in using Sulfuric Acid or Oleum is eliminated.

BENEFIT No. 3 **Improve Sulfonation Efficiency**

SULFAN has 99.5% SO_3 available for sulfonation reactions; thus, for many applications SULFAN offers nine times as much usable SO_3 as 100% Sulfuric Acid and over three times as much as 20% Oleum. This can mean a considerable saving in sulfonation costs.

BENEFIT No. 4 **Step Up Processing Efficiency**

The absence of waste acid when using SULFAN permits larger batch sizes or more rapid through-put in a sulfonation process. This means that by using SULFAN, batch size or through-put can be doubled or tripled without increasing the size of the equipment.

Tank Car Quantities

A laboratory development just a few short years ago, SULFAN today is a commercial chemical of ever-growing importance. This new processing tool is now being regularly shipped to many users in tank car quantities. For technical data on SULFAN, experimental quantities, or other assistance, contact any General Chemical office listed below.

Basic Chemicals For American Industry

Allied Chemical

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville • Kalamazoo • Los Angeles • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Providence • San Francisco • Seattle • St. Louis • Yakima (Wash.)

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

For more data on advertised products, use Readers' Service Cards, last page.

Bingham REFINERY PUMPS

designed **HOT or** *including*

AND NOW! THE NEW TYPE "CADS" DOUBLE-SUCTION, DOUBLE-VOLUTE PROCESS PUMPS FOR LOW NPSH CONDITIONS

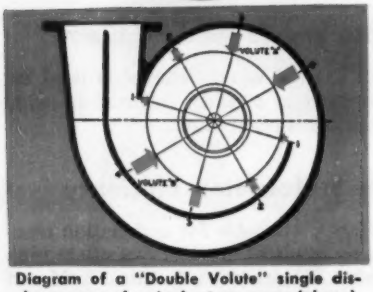


Diagram of a "Double Volute" single discharge case of a single stage pump (above), showing equal pressures on opposite sides of impeller. There is no "SIDE-PUSH"... insuring low maintenance.

Diagram of "Single Volute" pump case (below) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

The new Type "CADS" Single-Stage Double-Suction Process Pumps for hot or cold service are available as an addition to the complete line of Bingham Pumps for refinery service (shown below). These new pumps, like other Bingham Process equipment, feature unit-type bearings and rotating assemblies which, with spacer-type couplings, are readily removable without disturbing suction or discharge piping, or drivers.

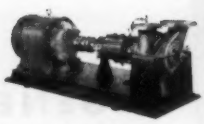
The new Type "CADS" has a "Double-Suction" impeller with exceptionally large eye areas, thus making it particularly suitable for low NPSH conditions. With a double suction impeller, the stuffingbox is under suction pressure only. The new Type "CADS" has been thoroughly field tested, and has rendered efficient, reliable service — with low maintenance — wherever it has been installed. Your nearest Bingham office will be glad to give you full details on request.

TYPICAL BINGHAM "DOUBLE VOLUTE"

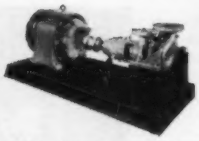
Bingham Type HPD "Double Volute" Multi-Stage Double Case "Hi-Press" pump for extremely high pressure service.

Bingham Type VS Single-Stage "Double Volute" Wet-Pit Pump for high capacity, medium head service.

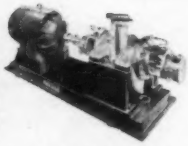
Bingham Type CP "Double Volute" Multi-Stage, Double-Case pump for hot or cold service.



Bingham Type CKA "Double Volute" Single-Stage Koke-Krusher for coke-laden pumpage.



Bingham Type CAD "Double Volute" Single-Stage Process Pump.



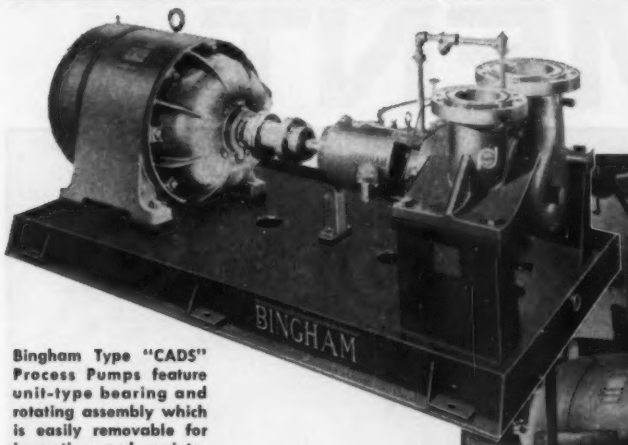
Bingham Type CM vertically split-case two-stage pump for hot service.

to meet all Operating Conditions for

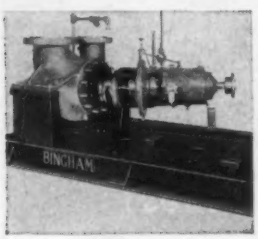
COLD HYDROCARBONS

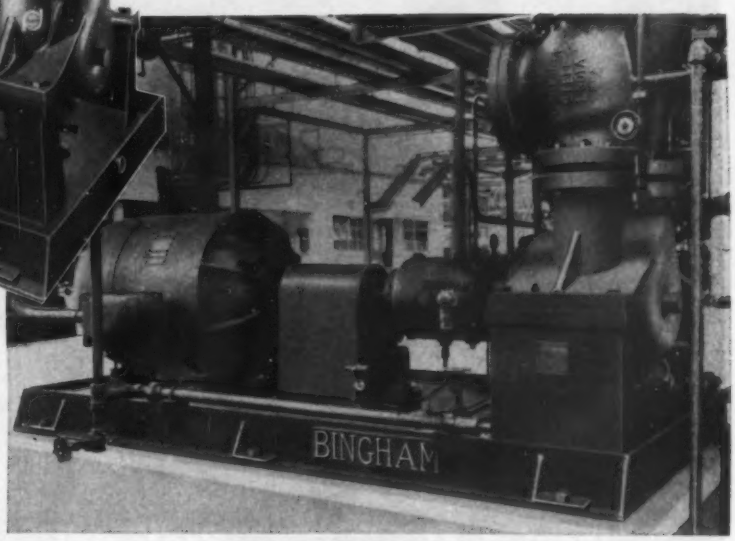
minimum NPSH requirements

Bingham Type CADS Pumps are available in sizes to meet a wide range of heads and capacities, with low NPSH conditions.



Bingham Type "CADS" Process Pumps feature unit-type bearing and rotating assembly which is easily removable for inspection and maintenance.





One of a battery of Bingham Type "CADS" Pumps in operation at Gulf Oil Co., refinery, Port Arthur, Texas.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

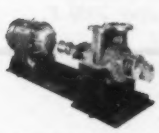
General Offices: **2800 N. W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B. C., Canada**

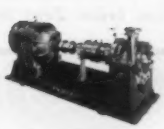
SALES AND SERVICE OFFICES

BOSTON, MASS.
CHICAGO, ILL.
CLEVELAND, OHIO
DALLAS, TEXAS
DENVER, COLO.
HOUSTON, TEXAS
KANSAS CITY, MO.
LOS ANGELES, CALIF.
NEW ORLEANS, LA.
NEW YORK CITY, N. Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

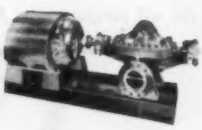
PUMPS FOR EVERY REFINERY SERVICE



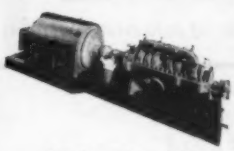
Bingham Type CD "Double Volute" Double Suction vertically-split case pump for hot service.



Bingham Type CJ "Double Volute" Two-Stage Process Pump for high heads.



Bingham Type HSB "Double Volute" Double Suction Pump for high heads.



Bingham Type MSB Horizontally Split-Case "Double Volute" Multi-Stage Pump for high pressure hot or cold service.

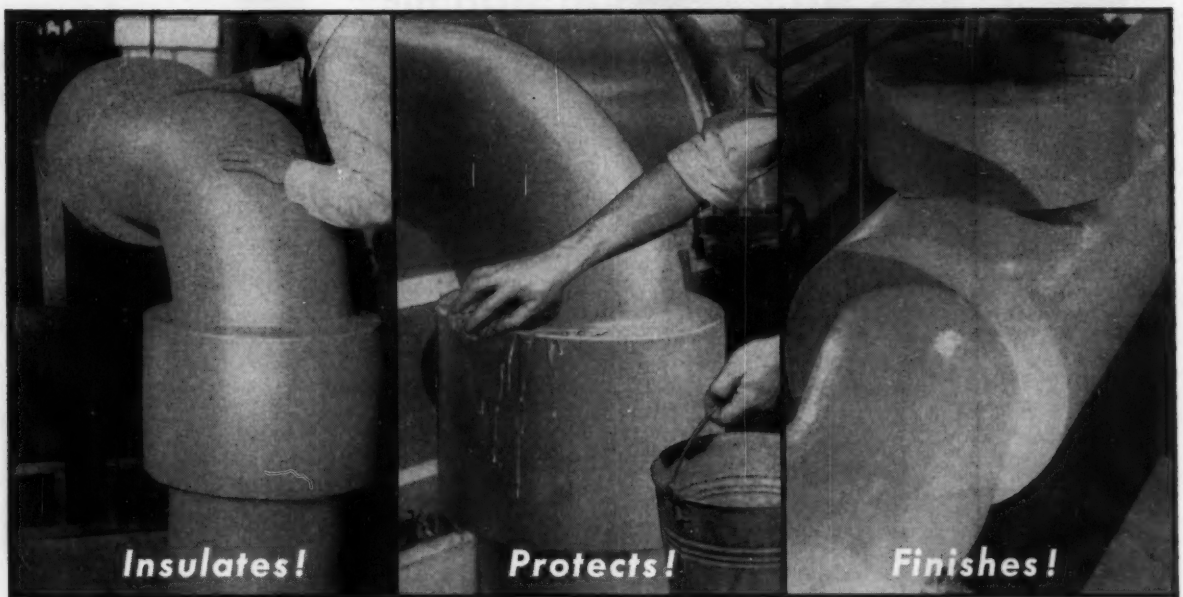
Bingham Type KT Stuffing-boxless Pump for high suction pressures and cold service.

Bingham Type VCP Vertical Pump for low NPSH conditions, featuring bottom dismantling.

For more data on advertised products, use Readers' Service Cards, last page.

1 QUICK APPLICATION INSULATES, PROTECTS, FINISHES!

EAGLE-PICHER
ONE-COTE CEMENT



- Saves time, work, money! One quick application provides smooth, light reflectant surface on hot or cold equipment!
- Clean, easy to handle! Just trowel it on—even on irregular areas where application of other insulations is often impractical.
- Highly efficient! Effective insulation at temperatures up to 1000 F.
- For outdoor installations! Quick-setting, withstands rain and moisture two hours after application. Prevents rust!
- For indoor installations! Requires no wire mesh or finishing treatment!

FREE SAMPLE!
Write today!

Prove to yourself, on your equipment, how Eagle-Picher One-Cote Cement can save you time, money and valuable man-hours.

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

Since 1843

EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

For more data on advertised products, use Readers' Service Cards, last page.

OIC VALVES

MOST COMPLETE MODERN LINE . . .

BRONZE

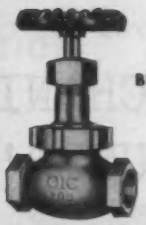


FIG. 520

FIG. 7100

Featuring union type, body-bonnet joint. ⅛″ to 3″. 125, 150, 200, 300 and 350 WSP; 200 to 2,500 WOG.

DURABLE AND SAFE . . .

CAST STEEL

FIG. 3002

FIG. 1372

Excellent for higher temperatures and pressures. 2″ to 16″. 150, 300 and 600 lb. primary pressure series.

29 TYPES, 9 TRIM VARIATIONS . . .

IRON

FIG. 1140

FIG. 124

FIG. 333

Includes end-seated seat rings for streamlined flow and longer service. 1¼″ to 16″. 125, 150 and 250 WSP; 175, 200, 400 and 500 WOG. ¼″ to 4″ U-Bolt gates.

1000 BRINELL DURACASE TRIM . . .

FORGED STEEL

FIG. 1021

FIG. 1321

FIG. 1720

Extra-hard, duracase trim, plus your choice of bolted or union type, body-bonnet joint. ¼″ to 2″ gate, globe, angle, check; 600 lb. primary pressure series.

TRIPLE-SEALED AGAINST LEAKS . . .

LUBRICATED PLUG VALVES

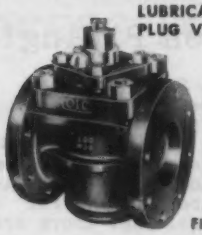


FIG. CR-212

Exclusive design ends shank leakage, holds adjustment, reduces maintenance. ½″ to 12″. Iron, 175 psi to 800 psi working pressures. Cast steel, ASA 150 lb. and 300 lb. pressure classes.

Write for the OIC valve cross reference booklet. It compares valves of 15 manufacturers. Request also new specification literature on the valve lines of your choice.

THE OHIO INJECTOR COMPANY

Wadsworth, Ohio

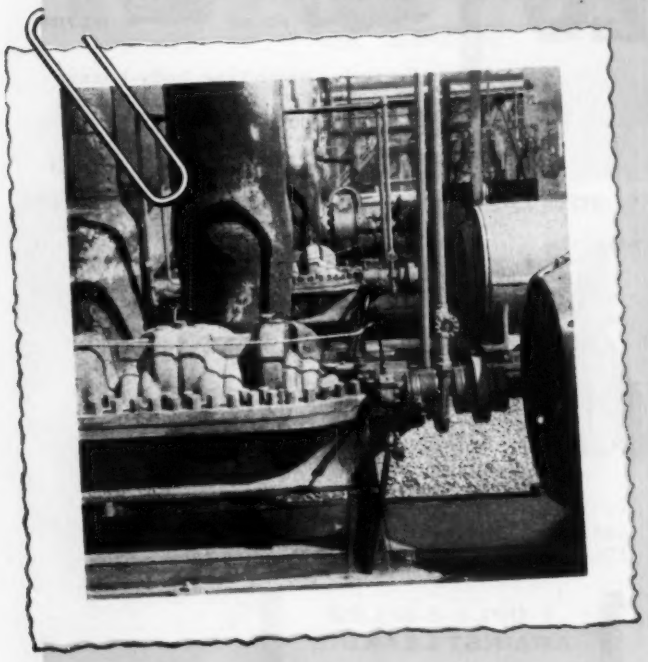
OIC VALVES

FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

BJ FIELD ENGINEERS' REPORT

Subject: Texas Gas Corp. installation

BJ MECHANICAL SEALS BOOST OLD PUMPS' OUTPUT 124 GPM . . . ELIMINATE NEED FOR NEW PUMP INVESTMENT!



Expansion of the Texas Gas Corporation's Winnie, Texas refinery created a need for 120 gpm more output than the existing high pressure charge pumps were delivering. Two solutions were considered: (1). add another pump of the same size as the pumps already in operation; or (2). purchase a large single-capacity pump to replace existing pumps.

Working with Texas Gas engineers, Byron Jackson suggested a third solution: install BJ Mechanical Seals on the existing pumps. This eliminated the use of packing and throttle bushings and stopped the extreme leakage loss occuring at these points.

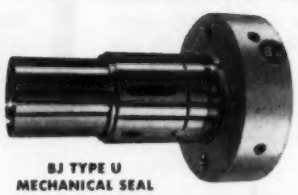
BJ Type U Mechanical Seals were installed on one of the pumps. Tests showed the flow rate was increased 62 gpm. The company immediately installed seals on their second charge pump. The new combined output of the mechanical-seal-equipped pumps was increased 124 gpm - more than sufficient to meet the expanded requirements.

In addition to this tremendous increase in pumping efficiency, other big benefits were realized: elimination of repacking expense and downtime losses; helpful savings in cooling water and piping; and a safer, cleaner working area around the pumps where formerly a "swamp" of leakage occurred.

Whatever your pumping requirements, it will pay you to investigate now the money-saving advantages of BJ Mechanical Seals. Call your local Byron Jackson office or write . . .

90% Saving on Piping!

After BJ Mechanical Seals were installed, approximately 90% of the piping was removed from the pumps. This maze of piping with packing had previously been necessary for cooling the stuffingboxes and for recirculating the high pressure leakage from the throttle bushings. Now there are only two lines used for handling cooling water to the bearing boxes and a 1¼" line running from seal cover to seal cover.



BJ TYPE U
MECHANICAL SEAL

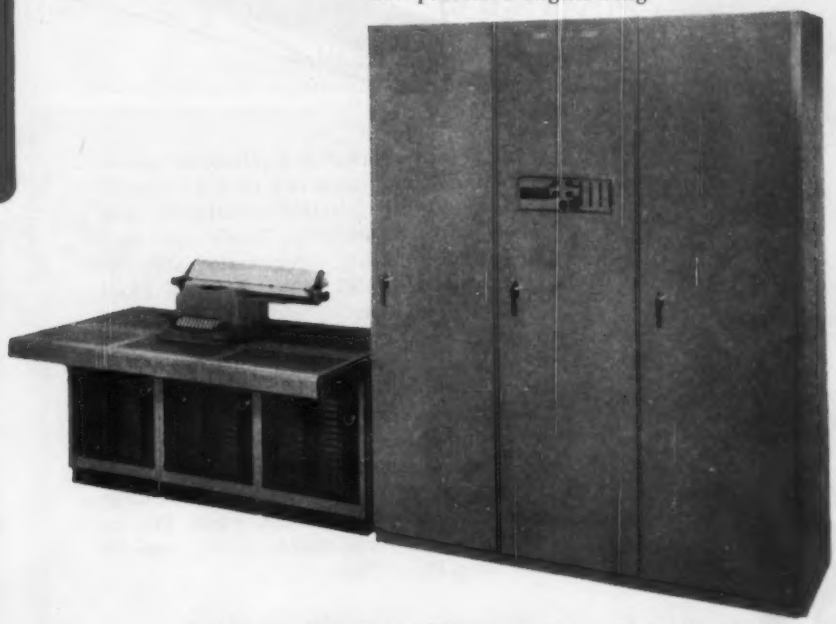
BYRON JACKSON PUMPS
INCORPORATED

A Subsidiary of Borg-Warner Corporation
P. O. BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

KYBERNETES®

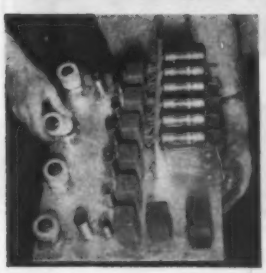
THE KYBERNETES CORPORATION

Division of Self Winding Clock Company, Inc.
for 70 years leader in time standards
and precision engineering



ALL ELECTRONIC LINE OF AUTOMATIC DATA PROCESS LOGGERS

A revolutionary engineering concept, the Kybernetes Electronic Data Logger puts to use designs largely predicated upon advanced techniques developed by the computer industries, featuring reliability and accuracy.



KYBERNETES®

Write for Bulletin '108'

THE KYBERNETES CORPORATION

Executive Offices:
9 East 40th Street
New York 16, N. Y.
MUrray Hill 3-6030

For more data on advertised products, use Readers' Service Cards, last page.

MULTIGRIP FLOOR PLATE is high-safety, low-upkeep factor at Gulf Refinery

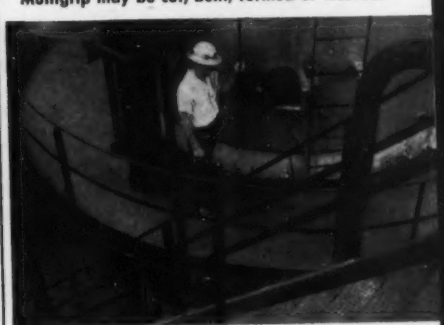
Port Arthur, Texas . . . hometown of huge refineries. Here, rambling refinery units of Gulf Oil Corporation are connected by a labyrinth of catwalks, ladders, ramps, walkways and steps. Traffic lanes such as these call for durability, safety and cleanliness. That's why you see USS Multigrip Steel Floor Plate wherever you look.

Multigrip tough steel floor plates have flat-topped, clean-edged risers that mean safe traction *from any direction.* The plates stand up under rugged service, year after year, without chipping, cracking or splintering. And cleaning them is a breeze—a hose or broom does the job. You can cut, weld, bend or shape Multigrip with ease, and large plates mean minimum installation waste. For increased safety and reduced maintenance . . . specify USS Multigrip Floor Plate.

Flat-topped risers give years of accident-free service.

Multigrip is available in large plates, eliminating waste of material and providing quicker installation, thus reducing cost.

Multigrip may be cut, bent, formed or welded.



UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS multigrip

FLOOR PLATE

Sold by leading distributors from coast to coast

7-209

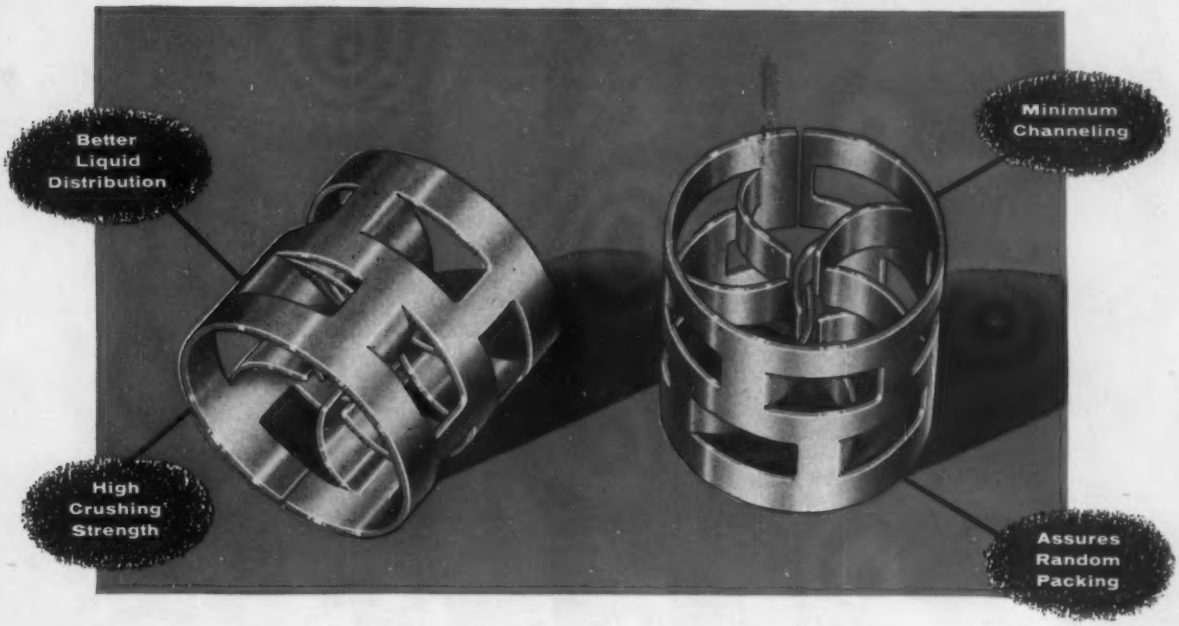
UNITED STATES STEEL

A new step forward in Tower Packings

METALLIC PALL RINGS

• Lower Pressure Drop • Better Mass Transfer Efficiency

• Lower H.E.T.P. Characteristics



The Pall Ring is like the Raschig Ring in that diameter and height are equal. In the Pall Ring, however, sections of the ring wall are stamped and bent inward—making the inside surface area substantially more effective. So much more so, in fact, that if a given separation could be carried out in a 12 foot column using metal Raschig Rings, it could be handled in a 9 foot column with metal Pall Rings.

In absorption, distillation or extraction the new patented Pall Ring offers advantages of major importance. They are now available in three sizes: 1″, 1½″ and 2″ in carbon steel, stainless steel, aluminum and copper. Typical data appears in the table below.

O.D. and Length (inches)	Wall Thickness	Number per Cubic Foot (approx.)	Weight per Cubic Foot in lbs. (Carbon Steel)	Surface Area (sq. ft./ cu. ft.)	Per Cent Free Gas Space
1″	24 Gauge	1520	33	66.3	93.4
1½″	22 Gauge	490	30	48.1	94.0
2″	20 Gauge	210	27.5	36.6	94.1

Write for this new booklet!

Technical data and full specifications on the complete line of U. S. Stoneware Tower Packings, including the new Pall Ring. Ask for Bulletin TP-54.

U. S. STONEWARE

AKRON 9, OHIO

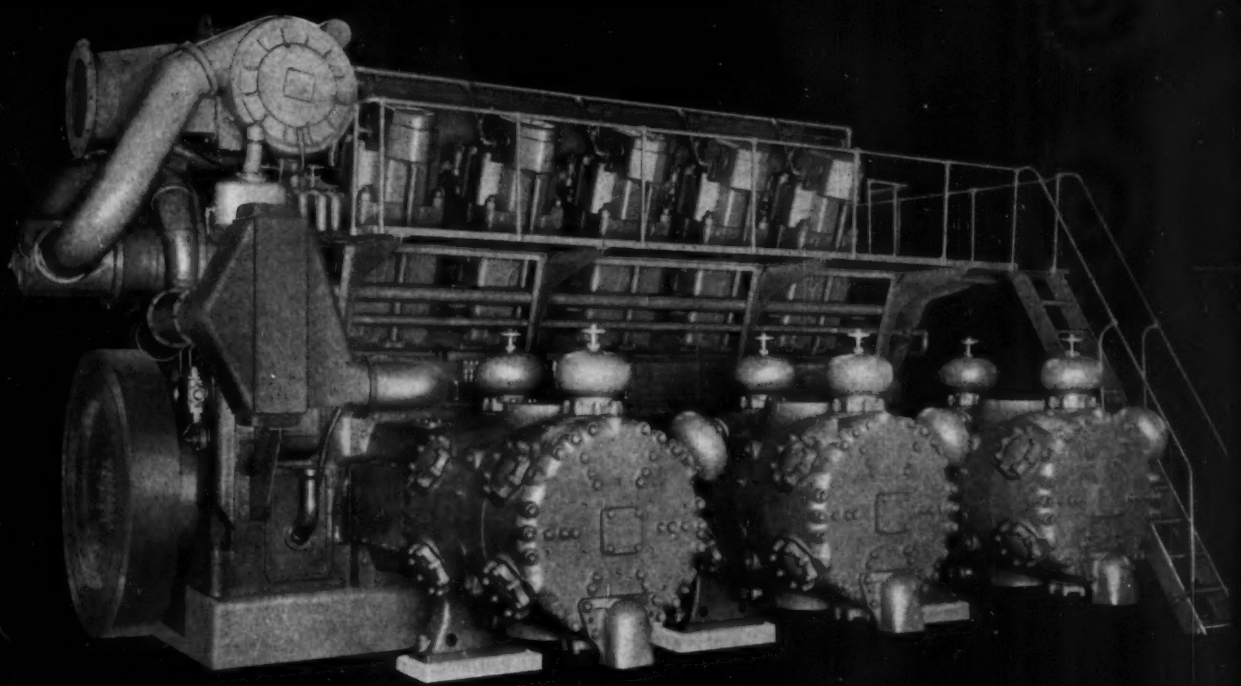
483-E

Announcing....

Cooper-Bessemer

SERIES TURBOCHARGED

V-Angle Compressors



... in a range of sizes including the most powerful and most efficient engine-driven compressors available today!

This unique development, with exhaust-driven and engine-driven turbo-compressors operating in series, provides *denser* air in abundant volume for a new high in combustion and scavenging efficiency.

Only Series Turbocharged V-Angles offer the following combination of feature advantages . . .

1. **A full 40% more horsepower than immediate predecessor engines of the same bore, stroke and speed (up to 3,500 bhp at 250 rpm).**
2. **Greatly increased thermal efficiency, with lower guaranteed fuel consumption.**
3. **Lower investment in heat dissipation equipment.**
4. **Higher-than-ever horsepower-to-space ratio.**
5. **Unmatched economy in the cost per horsepower of housing, foundation, piping, supervision and maintenance.**
6. **No de-rating for altitude! Full rated power up to 7500 feet.**
7. **Efficient turbocharging right from the start-up and throughout all loads and speeds.**
8. **Highly successful, field-proved performance.**

for further details on Series Turbocharging, its unusual advantages and just how it operates, send for new bulletin No. ST-82... or contact the nearest Cooper-Bessemer office.

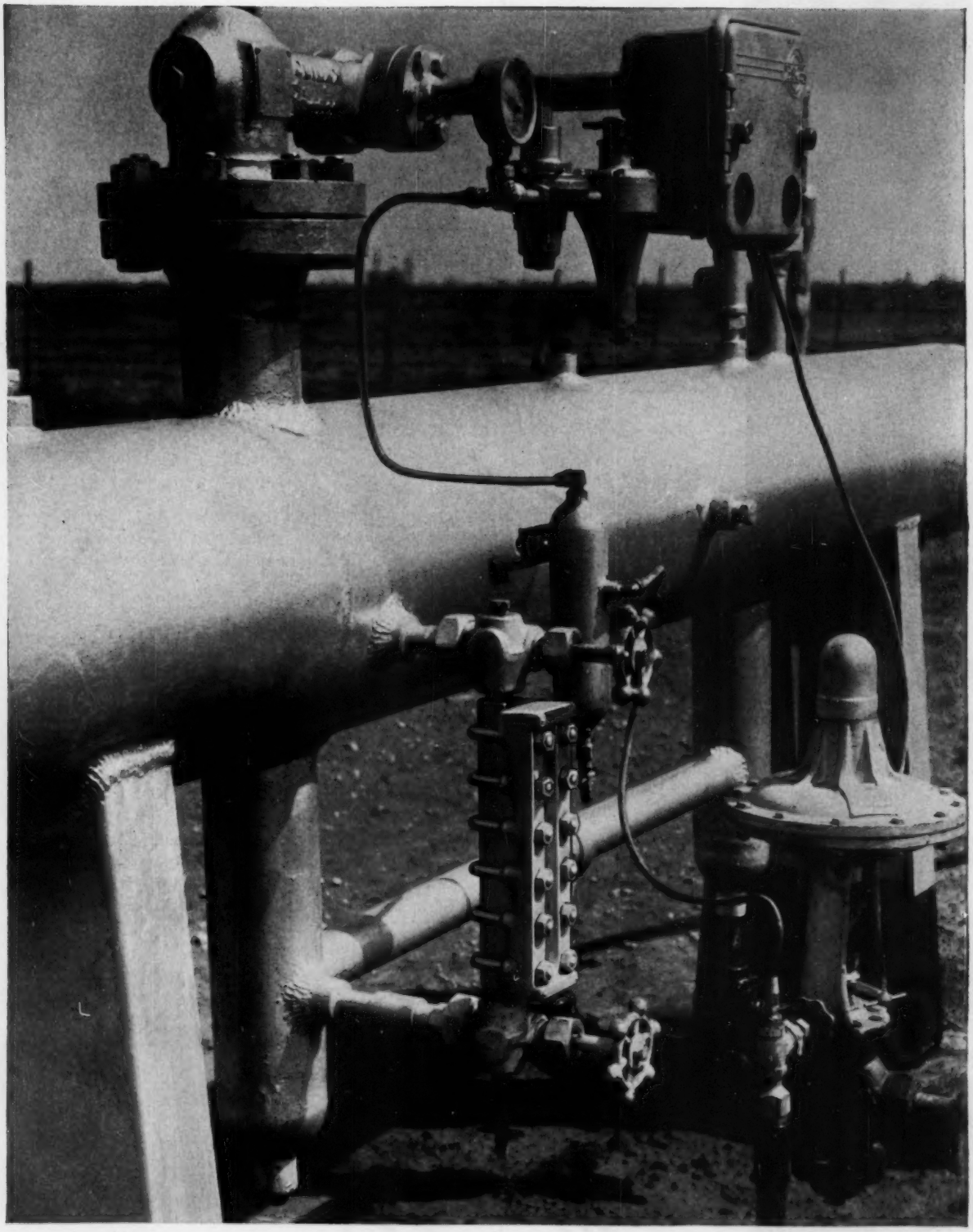
BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis • New Orleans • Shreveport • Casper

SUBSIDIARIES: Cooper-Bessemer of Canada, Limited . . . Edmonton • Calgary • Halifax.
Cooper-Bessemer International Corporation . . . New York
Chacao • Havana • Mexico City

Cooper/Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN



● **PENBERTHY GAGE** on Black, Sivalls & Bryson, Inc., oil and gas separator, South Cowden Field, Ector County, Texas.

Everywhere... YOU'RE SEEING MORE PRODUCTS BY

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
1242 Holden Avenue **Detroit 2, Michigan**

PENBERTHY

- EJECTORS
- INJECTORS
- CYCLING JET PUMPS
- ELECTRIC SUMP PUMPS
- LIQUID LEVEL GAGES
- GAGE VALVES

For more data on advertised products, use Readers' Service Cards, last page.

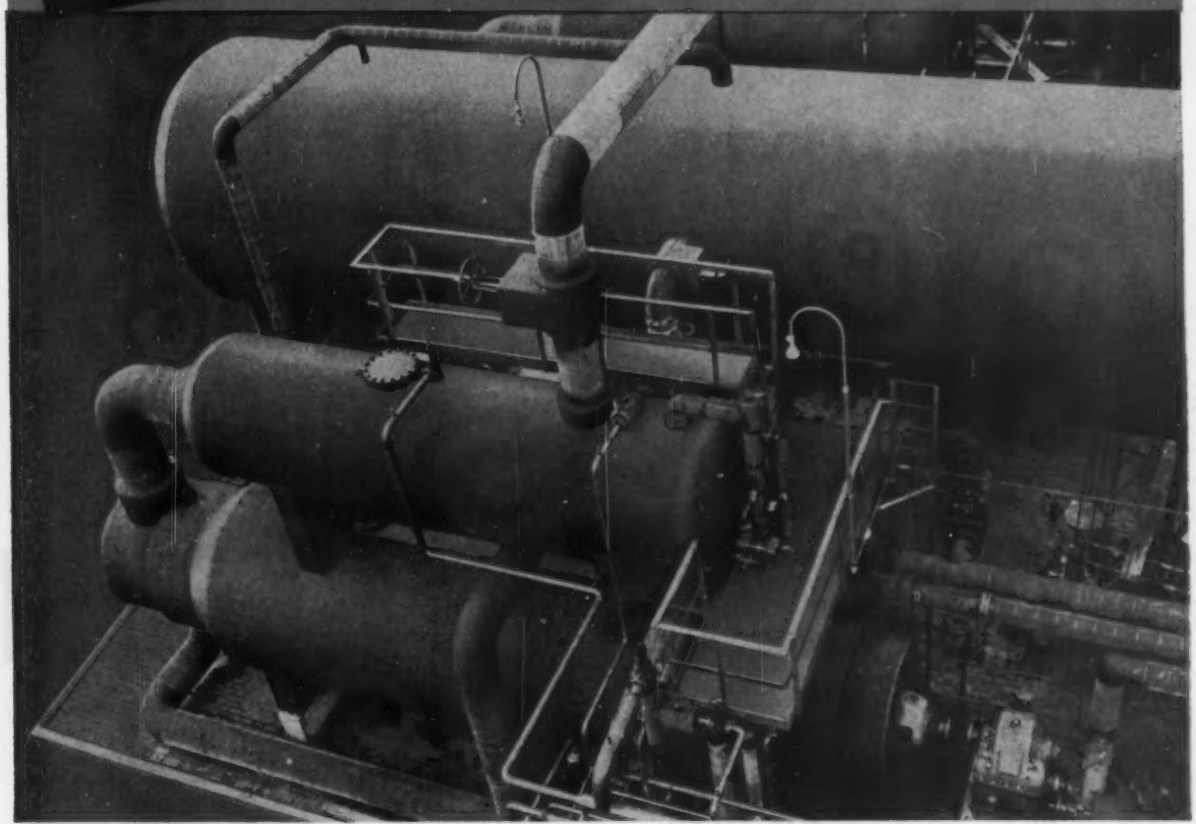
A SHORT STORY...

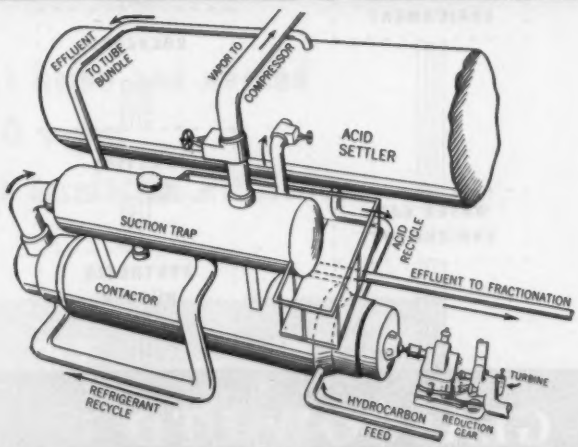
About the Advantages of

STRATCO

Reg. U. S. Pat. Off.

EFFLUENT REFRIGERATION* ALKYLATION





HERE'S WHAT IT LOOKS LIKE...

HERE'S WHY IT PAYS...

This type of reaction system, utilizing the horizontal Stratco contactor and the Stratco effluent refrigeration recycle, produces higher yield, higher quality alkylate with less catalyst consumption and lower capital investment.

21 Contactors now operating with Effluent Refrigeration

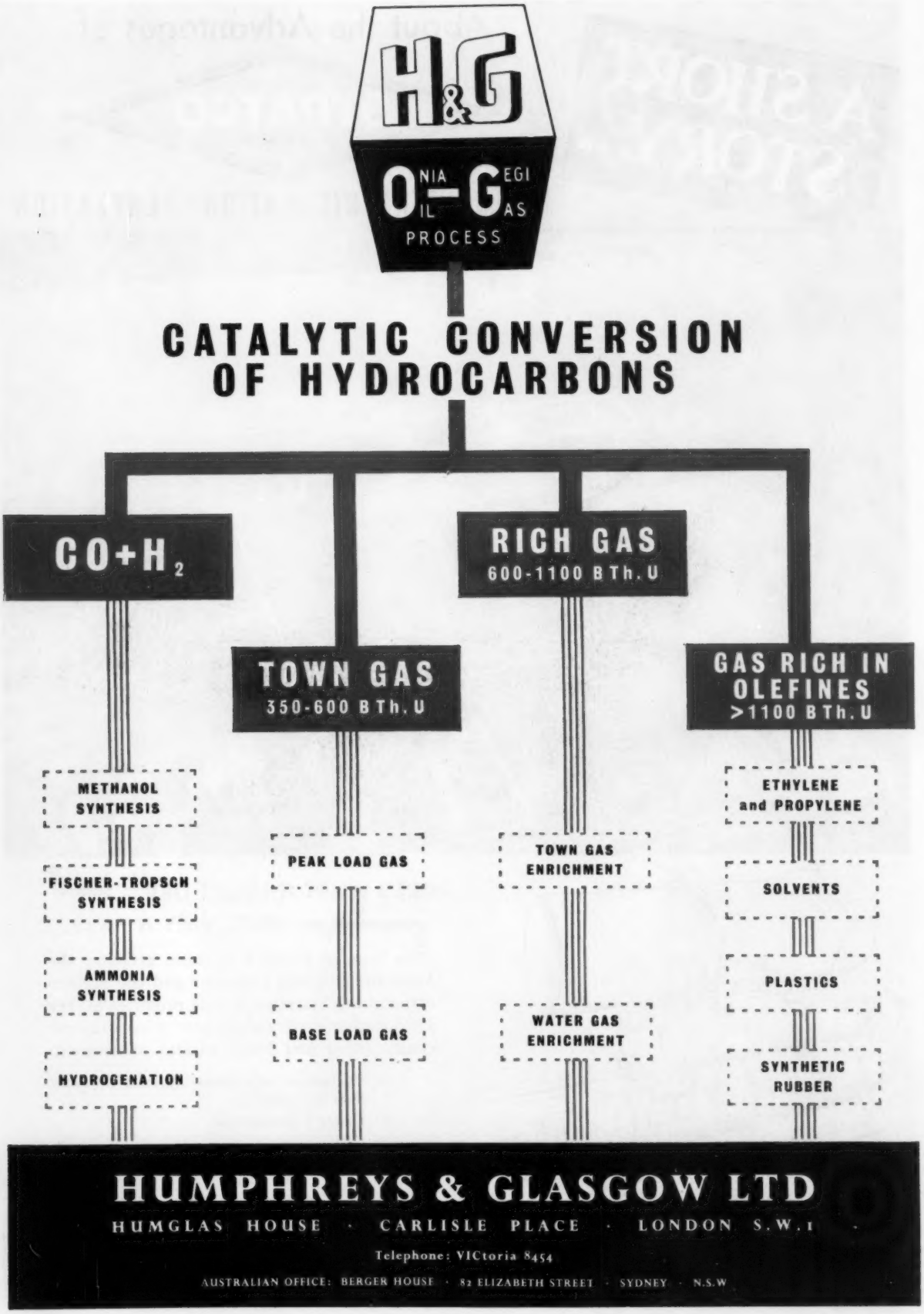
20 Under construction.

*Licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

STRATFORD ENGINEERING Corporation

612 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.

For more data on advertised products, use Readers' Service Cards, last page.

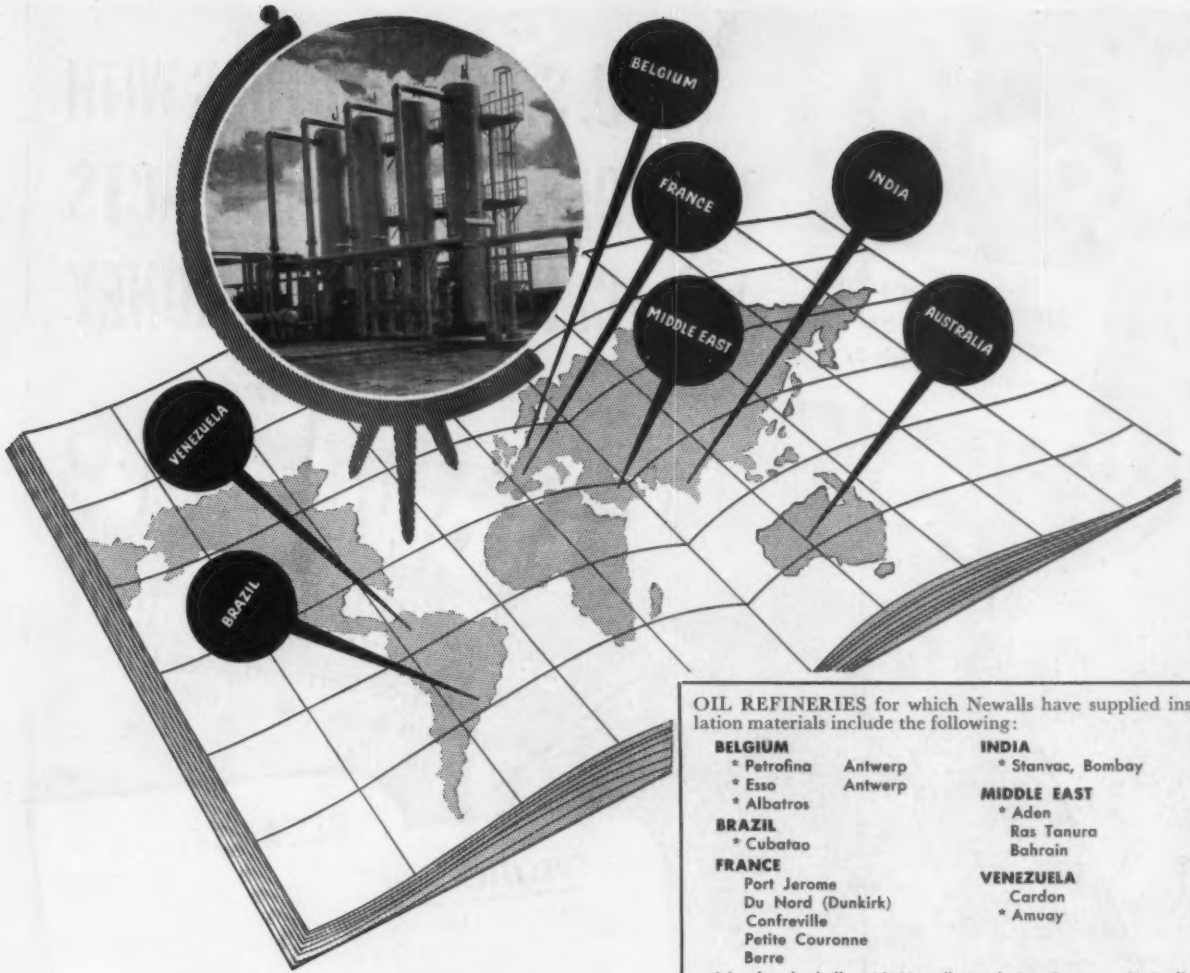


HUMPHREYS & GLASGOW LTD

HUMGLAS HOUSE · CARLISLE PLACE · LONDON S.W.1

Telephone: VICtoria 8454

AUSTRALIAN OFFICE: BERGER HOUSE · 82 ELIZABETH STREET · SYDNEY · N.S.W



OIL REFINERIES for which Newalls have supplied insulation materials include the following:

BELGIUM
* Petrofina — Antwerp
* Esso — Antwerp
* Albatros

BRAZIL
* Cubatao

FRANCE
Port Jerome
Du Nord (Dunkirk)
Confreville
Petite Couronne
Berre

INDIA
* Stanvac, Bombay

MIDDLE EAST
* Aden
Ras Tanura
Bahrain

VENEZUELA
Cardon
* Amuay

* Insulated wholly with Newalls Insulation Company Limited's materials.

At home and abroad 50 years of insulation efficiency

Since the turn of the century Newalls have built up a world-wide reputation for efficient insulation of all types of industrial and marine projects.

To the rapid expansion of the oil industry during the past two decades, Newalls were able to bring a wealth of experience and the benefit of proved insulation techniques from other fields, contributing greatly to effective temperature control and new peaks of operating efficiency in oil refinery work. Newalls provide an international contracting organisation equipped to handle insulation treatment on refineries in all world markets with their well-known range of time-proved materials, including Newalls (Regd. Brand). 85% Magnesia, Nicosil, Newtempheit, and Amosite Asbestos products to meet temperatures from —300° F. up to over 2,000° F.

Newalls Technical Advisory Service will assist on all insulation matters from plant conception to installation. We invite you to take advantage of our comprehensive service.

Newalls

NEWALLS INSULATION CO., LTD.

NEWALLS INSULATION CO., LTD. *Head Office: WASHINGTON, CO. DURHAM*

A member of the TURNER & NEWALL ORGANISATION

Agents and Vendors in most markets abroad

U. S. CONTRACTORS WITH OFF-SHORE CONTRACTS CAN SAVE REAL MONEY

by specifying

FLOWFORGE

FORGE-WELDED
OPEN STEEL FLOORING
Plain or Serrated edges
(plain edges illustrated)

BECAUSE:

SPECIFICATION

Flowforge Open Steel Flooring is designed to meet U. S. specifications. Recent Test Reports from the Physical Laboratory Division of the Robert W. Hunt Company, of Chicago, U.S.A. are available for examination. All load figures stated in our literature are guaranteed.

SERVICE

Large stocks of standard panels, 20 ft. span x 3 ft. wide, are held ready for IMMEDIATE shipment to any part of the world. Delivery schedules for tailor-made panels can be arranged to meet site requirements.

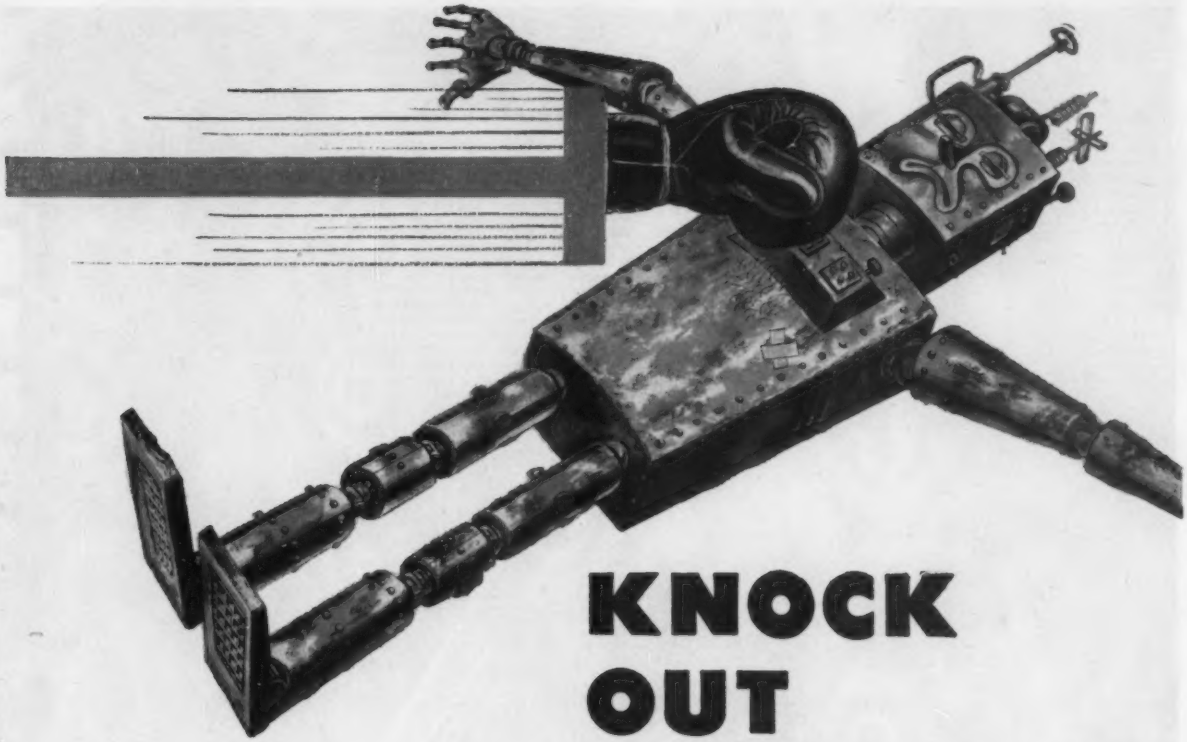
SAVING

Recent contracts, secured against World competition, testify that Flowforge is not only comparable in quality and service, but is lowest in first cost. Contracts have been received from the U. S. Army Air Force, and many important American Companies.

Full information will be mailed immediately we receive details of your requirements.

Fisher & Ludlow Ltd

MATERIAL HANDLING DIVISION · BORDESLEY WORKS
BIRMINGHAM 12 **ENGLAND**
Cables: FLOWLINE, BIRMINGHAM, ENGLAND



KNOCK OUT CORROSION WITH ALKATERGE-T

Alkaterge-T is fulfilling its early promise of being an exceptional oil-soluble corrosion inhibitor. It passed two commonly used screening tests with the most gratifying results and industrial users are finding confirmation in practice.

At least part of its success is probably due to its very powerful adhesion to metallic and other hydrophilic surfaces. The force required to break this adhesion has been measured at 10,500 psi — highest of any compound tested. Alkaterge-T is a big molecule and with this adhesion, powerful protection would be expected by most corrosion engineers. But Alkaterge-T has a plus value, too. Mildly alkaline, it will tie up any trace of acidity that may develop, yet it is harmless to brass. This product, therefore, should be evaluated by every manufacturer of rust preventive oils, lubricants, cutting oils, extruding oils, transformer oils, corrosion resistant greases, and spinning and throwing oils for the textile industry.

Alkaterge-T is a powerful emulsifying agent for water-in-oil emulsions and is unaffected by hard water. As little as 1% will emulsify 80% water into aliphatic hydrocarbons and form a fluid, stable emulsion. In lubricating formulations, Alkaterge-T tends to prevent sludge formation resulting from moisture pickup and should be of interest in crank case flushing oils and fuel oils. It should also be evaluated as a liquefier for the water-in-oil sludges that present severe problems in automobile crankcases, fuel oil tanks and crude oil production.

For further information and samples, write Commercial Solvents Corporation today.

ALKERTERGE-T TYPICAL PHYSICAL PROPERTIES

Color (melted), Gardner (1933)	12 max
Solidification Point, °C	59
Interfacial Tension against water, 0.1% solution in mineral oil	1.8 dynes/cm
Surface Tension, saturated aqueous solution	30.4 dynes/cm
Flash-Point	None
Solubility in water at 25 °C	0.01 ml/100 ml

DISCOVER THE NITROPARAFFINS!

INDUSTRIAL CHEMICALS DEPARTMENT

COMMERCIAL SOLVENTS CORPORATION

260 MADISON AVE., NEW YORK 16, N. Y.

Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston • Indianapolis • Kansas City • Los Angeles
Louisville • Memphis • Milwaukee • New Orleans • New York • Pittsburgh • St. Louis • San Francisco
IN CANADA: Reliance Chemicals, Ltd., Montreal. IN MEXICO: Comsolmex, S. A., Mexico 11, D. F.

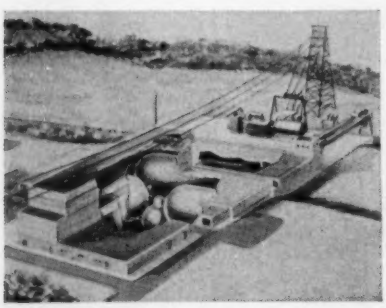
For more data on advertised products, use Readers' Service Cards, last page.

Anaconda Arsenical Admiralty-439 Tubes being installed in the condenser at the Shippingport, Pa., Atomic Power Plant—25 miles northwest of Pittsburgh.

CONDENSER IN AMERICA'S FIRST BIG ATOM POWER PLANT USES 60 MILES OF ANACONDA ARSENICAL ADMIRALTY TUBE

The electric generating station at the Shippingport, Pa., Atomic Power Plant will add a maximum 100,000 kw of electric power capacity to Duquesne Light Company's system when it is placed in operation this year.

More significant, however, is its function of measuring the performance of the Pressurized-Water Reactor. It will help give some of the answers on how to "burn" uranium on a large scale and utilize the power economically, to guide design of future atomic power plants.



A SKETCH of The Shippingport Atomic Power Plant, cut away to show containment vessels housing the pressurized-water reactor and heat exchangers which generate steam to operate the turbine-generator. The condenser is located directly beneath the turbine-generator shown in the background.

The Westinghouse Turbine-generator has a minimum rating of 60 megawatts and a maximum of 100 megawatts. It operates on saturated steam at low pressure—987,350 lb/hr at a throttle pressure of 620 Psia, for 79.3 megawatt gross generator load. It is served by a 70,000-sq.-ft. Westinghouse condenser which provides a condenser vacuum of 1.5 in Hg Abs.

The condenser has a total of 10,276 Anaconda Arsenical Admiralty-439 tubes, 7/8" O.D. x 18 Stubs' gage x 30 ft. long, with a total weight of 153,676 lb. The tube plates of "true oval shape," 153" x 213" x 1½" thick, are of Leaded Muntz Metal, each weighing approximately 12,450 lb. These, too, were supplied by The American Brass Company.

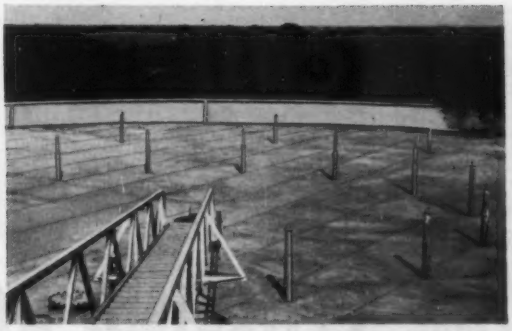
Oil Refineries have virtually made Anaconda Arsenical Admiralty-439 standard for refinery condensers and heat exchangers handling crudes, rerun stocks, cracked products, lubricating oils, and by-products. It is resistant to dezincification and can handle corrosive waters at relatively high temperatures. It can also withstand sulfur compounds encountered in refining sour crudes.

The American Brass Company laboratories are constantly studying corrosion problems to help make condensers and heat exchangers give longer and more dependable service—are leaders in the development of alloys to help meet the problems. Arsenical Admiralty is but one of its many contributions in the field.

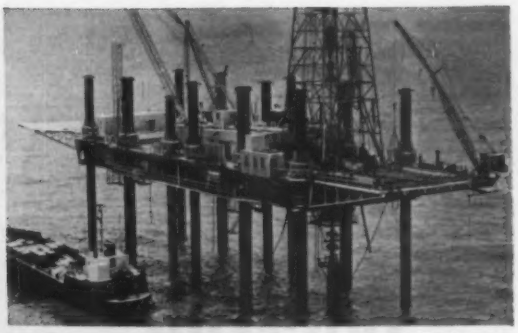
TECHNICAL SERVICE. The Technical Department of The American Brass Company will be glad to help you select the one best alloy for the conditions you face. For such special service or for information on Anaconda Tubes and Plates, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5784P

ANACONDA® **TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS**

MADE BY THE AMERICAN BRASS COMPANY



on shore . . .



or offshore

your own painter can
"COLD GALVANIZE"
any steel surface with...

DIMETCOTE
* the 100% inorganic zinc coating

any **PLACE**

any **TIME**

any **WHERE**

Dimetcote is absolutely unique. It is not a paint, it contains no oils, resins or any other organic materials, yet it can be applied by spray or brush. When Dimetcote is applied to steel, a reaction takes place at the surface which produces chemical bonding as well as physical adhesion. It is almost impossible to find the interface between Dimetcote and the steel.

Dimetcote has many unusual characteristics. It shows no visible change after more than ten years exposure to the most severe weather conditions – sun, heat, fresh and salt water. It is insoluble in all solvents and petroleum products. It is highly abrasion resistant, but if abraded through to bare steel, the coating will cathodically inhibit corrosion.

Now tanks and structures can be given the same protection that galvanizing affords, *plus salt water resistance.* Existing structures need not be dismantled and new structures can be coated either before or after erection. *Only one coat* of Dimetcote over a sandblasted surface is required to protect such structures as:

Tank Exteriors • Cargo Tanks in Tankers • Dam Gates • Structural Steel • Christmas Trees • Buoys • Floating Roof Tanks • Offshore Rigs • Water Tanks • Barges • Ship Decks • Stacks

AMERCOAT CORPORATION Dept. VE
4809 Firestone Blvd., South Gate, California
Please send illustrated folder on Dimetcote

Name_____
Title_____
Company_____
Address_____
City_____ Zone___ State_____

Amercoat® CORPORATION
4809 Firestone Blvd., South Gate, California

921 Pitner Avenue, Evanston, Illinois
360 Carnegie Avenue, Kenilworth, New Jersey
2404 Dennis Street, Jacksonville, Florida
6530 Supply Row, Houston, Texas

For more data on advertised products, use Readers' Service Cards, last page.

POSITIVE DISPLACEMENT

NO STUFFING BOX

Specify Lapp Auto-pneumatic PULSAFEEDER

. . . for Automatically Controlled Metering of Liquids

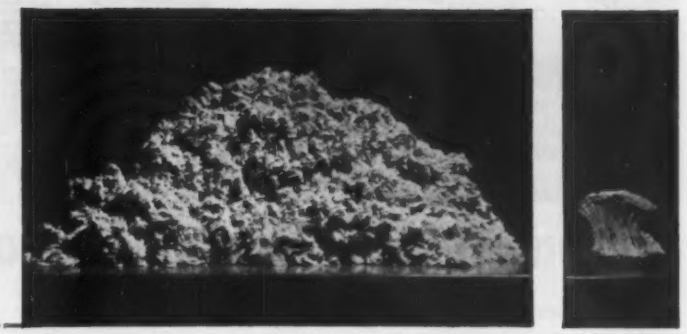
The outstanding features of the Lapp "Auto-Pneumatic" Pulsafeeder make possible continuous automatic processing of liquids which cannot be satisfactorily handled by plunger-type metering pumps. The "Auto-Pneumatic" Pulsafeeder is a piston-diaphragm pump providing positive displacement without the problems of a stuffing box. A hydraulically balanced Pulsafeeder diaphragm isolates the product from the working parts of the pump, preventing product leakage or contamination. With pneumatic instrument control, the pumping rate of the "Auto-Pneumatic" Pulsafeeder automatically adjusts from zero to full capacity. Manually adjustable models also available.

WRITE FOR BULLETIN 440 *with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 536 Wilson Street, Le Roy, New York.*

Lapp

Refinery Insulation

All CAPOSITE moulded insulation materials are made of Amosite asbestos. The photograph clearly demonstrates the immense volume which is obtained when the natural Amosite is fiberised—the sign of high efficiency as an insulating medium.



CAPOSITE is supremely well suited to the thermal insulation of oil refineries. With a limiting temperature of 1000°F., high thermal efficiency and great structural strength and resilience, CAPOSITE has gained for itself a unique position among thermal insulation materials used by the Oil Industry.

CAPOSITE MOULDED ASBESTOS FIBRE PIPE INSULATION

EFFICIENCY DATA SHEET—PIPE SIZES 6" to 10" BORE.

HOT FACE TEMPERATURE °F.			400°F			600°F			800°F		
THERMAL CONDUCTIVITY K = B.Th.U. in./sq. ft./hr./in./°F.			0.43			0.47			0.53		
MEAN TEMPERATURE °F.			250			350			450		
Nominal Pipe Size	O.D. pipe	Thickness of Insulation	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.	Heat Loss B.Th.U. sq. ft. hr.	Effic. %	Surface Temp. °F.
6"	6⅝"	1"	135	87·7	126	233	90·6	167	354	92·5	218
		1½"	102	90·8	107	177	92·9	135	270	94·3	171
		2"	83·6	92·4	97	145	94·1	118	223	95·3	145
		2½"	71·8	93·5	91	125	95·0	107	192	96·0	128
		3"	63·5	94·2	86	110	95·5	100	170	96·4	117
		3½"	57·3	94·8	83	100	96·0	95	154	96·7	109
		4"	52·6	95·2	81	91·7	96·3	91	142	97·0	103
8"	8⅝"	1"	130	88·0	127	225	90·8	169	341	92·7	222
		1½"	97·7	91·0	108	169	93·1	137	258	94·5	174
		2"	79·2	92·7	98	138	94·4	120	211	95·5	148
		2½"	67·4	93·8	92	117	95·2	109	180	96·1	131
		3"	59·2	94·6	87	103	95·8	102	159	96·6	120
		3½"	53·2	95·1	84	92·7	96·2	96	143	96·9	111
		4"	48·5	95·6	82	84·6	96·5	92	131	97·2	105

These figures are compiled from results of official tests by THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON, computed in accordance with formulae shown in BRITISH STANDARD SPECIFICATION appendices.

Please write for full technical details

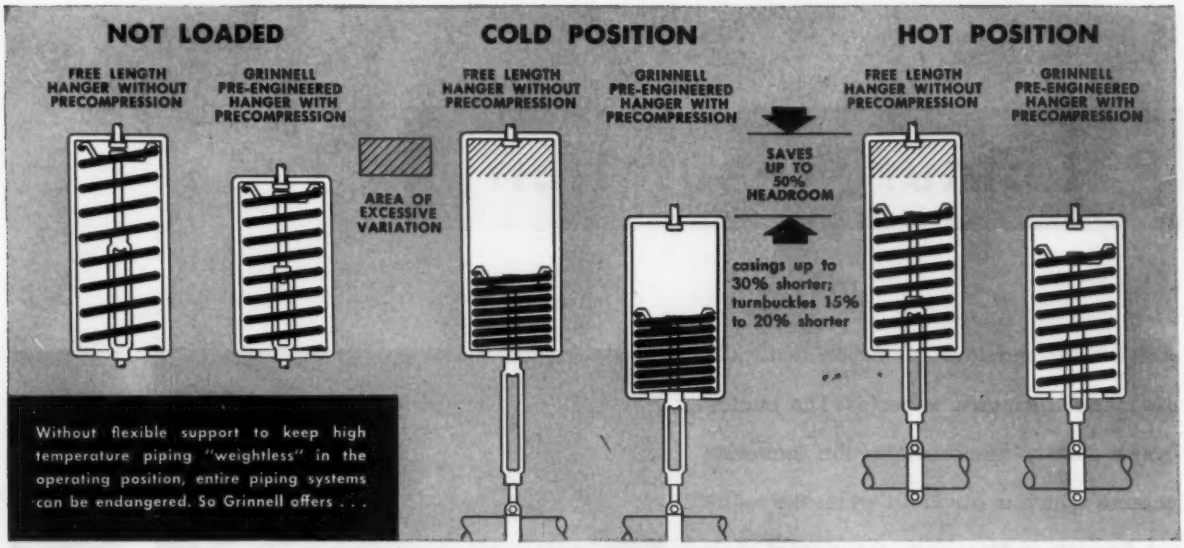
THE CAPE ASBESTOS COMPANY LIMITED
114 & 116 Park Street, London, W.1.
Cables: Incorrupt, London.

CAPOSITE REGD
Amosite Asbestos Blocks and Pipe Sections

Enquiries in CANADA to: Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.
U.S.A.: The North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois.
SOUTH AFRICA: Cape Asbestos South Africa (Pty.) Ltd., P. O. Box 2533, Johannesburg; ITALY: Capamianto S.P.A., via Sant' Antonino 57, Turin. FRANCE: Isolamiante S.A. 37 Avenue Franklin D. Roosevelt, Paris 8e.

CAPE

For more data on advertised products, use Readers' Service Cards, last page.


NOT LOADED
COLD POSITION
HOT POSITION
FREE LENGTH HANGER WITHOUT PRECOMPRESSION
GRINNELL PRE-ENGINEERED HANGER WITH PRECOMPRESSION
AREA OF EXCESSIVE VARIATION
SAVES UP TO 50% HEADROOM
casings up to 30% shorter; turnbuckles 15% to 20% shorter
Without flexible support to keep high temperature piping "weightless" in the operating position, entire piping systems can be endangered. So Grinnell offers . . .

Precompressed Hangers for Safer Support of Piping

Helical coil springs are widely used in hangers for flexible support of piping which moves up or down during thermal expansion. The A.S.A. code for pressure piping requires that variable spring hangers support at least a minimum of 75% of the pipe's weight for a pipe that rises (relaxing the spring) and no more than 125% of the pipe's weight for a pipe that lowers (compressing the spring) during operation.

Precompression patented Grinnell principle

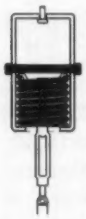
To guard against the spring's supporting force exceeding the limits of variation, Grinnell developed and patented a variable spring hanger design. The steel casing holds the spring permanently precompressed, at the threshold of the hanger's working load range. This prevents the spring decompressing into its area of excessive variation.

Pre-set is not a substitute

As a partial substitute for this patented precompression, some manufacturers insert a spacer between the top end of a free-length hanger casing and the spring to hold the spring's height temporarily within the working range during shipment and erection.

Another device requires the manufacturer to drill symmetrically opposite holes in the casing walls and insert a bolt to hold the spring's height within the working range. When these devices are removed from the hanger and discarded, the spring can decompress, resulting in high variability in supporting force.

Cold-setting a universal factory service

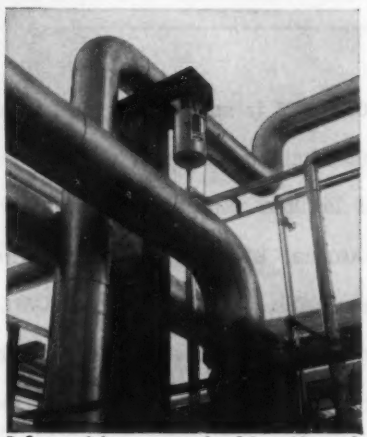


For the erection crew to avoid having to compress the spring down to the erected position, the manufacturer can compress the spring down to this height. Grinnell can provide a cold-set bolt in precompressed hangers.

Less headroom required by Grinnell Hangers

Shorter hanger casings made possible by Grinnell's patented precompression, reduce bulk shipping weight and required headroom by eliminating undesirable height. Installation is simplified by this shorter casing and also by an integral load scale with load indicator.

Additional headroom is saved by a correspondingly shorter turnbuckle. These precompression advantages are available in short spring and double spring models as well as standard spring models.



Refinery piping supported safely, with ample flexibility but low headroom.

Available in 63 standard units

Grinnell Variable Spring Hangers are available in 21 sizes each of short, standard and double spring models . . . for maximum travel of 1¼, 2½ and 5 inches respectively within working load ranges. Load capacities extend from 43 lbs to 30,550 lbs. The maximum variation in the standard size per ½-inch deflection is 10½% of rated capacity; inversely proportional in short spring and double spring models.

For further information

If you have a pipe suspension problem, you are invited to write: — Grinnell Company, Inc., 282 West Exchange Street, Providence, R. I.

This 150-Foot Hose
STRETCHES AROUND THE WORLD

Refueling-in-air techniques such as these now make possible non-stop trips around the world. But no matter where the refueling takes place, the pipeline begins at the nation's refineries.

With experts predicting that by 1965 refined product sales will have increased 2½ times over 1946, the need for efficient refinery operations is obvious. Perhaps Polyrad—the filming amine inhibitor and detergent—can play a role in your operation.

Polyrad forms a molecular film that protects metal from attack and reduces down time caused by corrosive damage. Polyrad's detergent action keeps metal surfaces clean to maintain heat transfer and operation at unit capacity.

A Hercules trained representative will be glad to tell you how Polyrad can protect your refinery. Stocks are maintained at strategic points throughout the country and overseas.

Pine Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY
INCORPORATED

976 Market St., Wilmington 99, Del.

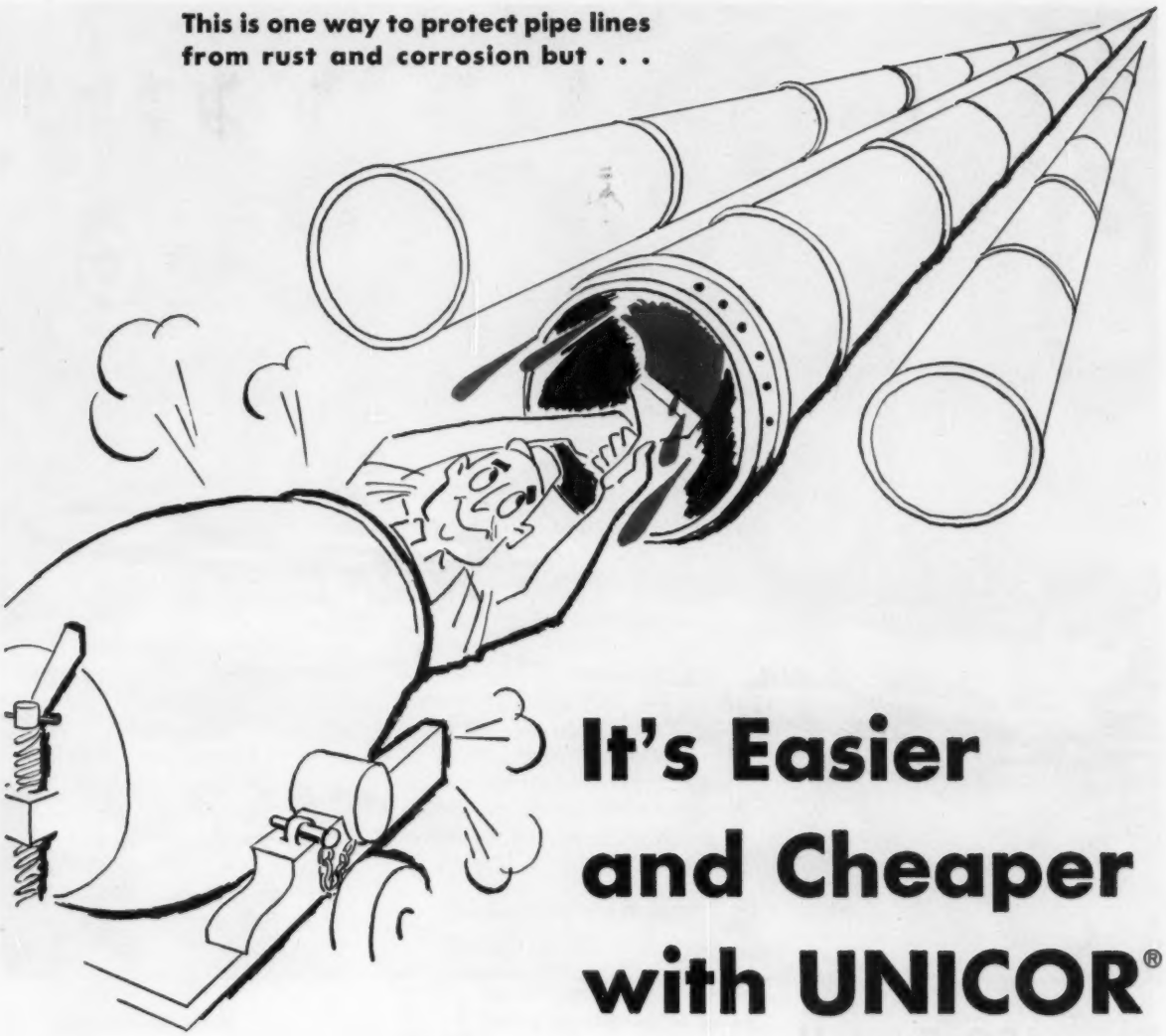
REFINERS RELY ON

POLYRAD®

FILMING AMINE INHIBITOR NA57-2

For more data on advertised products, use Readers' Service Cards, last page.

This is one way to protect pipe lines from rust and corrosion but . . .



It's Easier and Cheaper with UNICOR®

UNICOR, UOP's oil soluble corrosion inhibitor, gives dependable protection at suprisingly little cost. Actually only one molecule of Unicor is required for every million molecules of pipe line product. Its cost is only about $0.0005 per barrel of product.

It's economical to apply, too. Addition is made at only one point and since it is distributed evenly over the entire internal surface, protection is virtually 100% effective. There are important additional savings, too, from reduced scraper cleaning and filter replacement costs.

We will be glad to have our technical specialists assist you in the design, installation and operation of a Unicor system of protection.

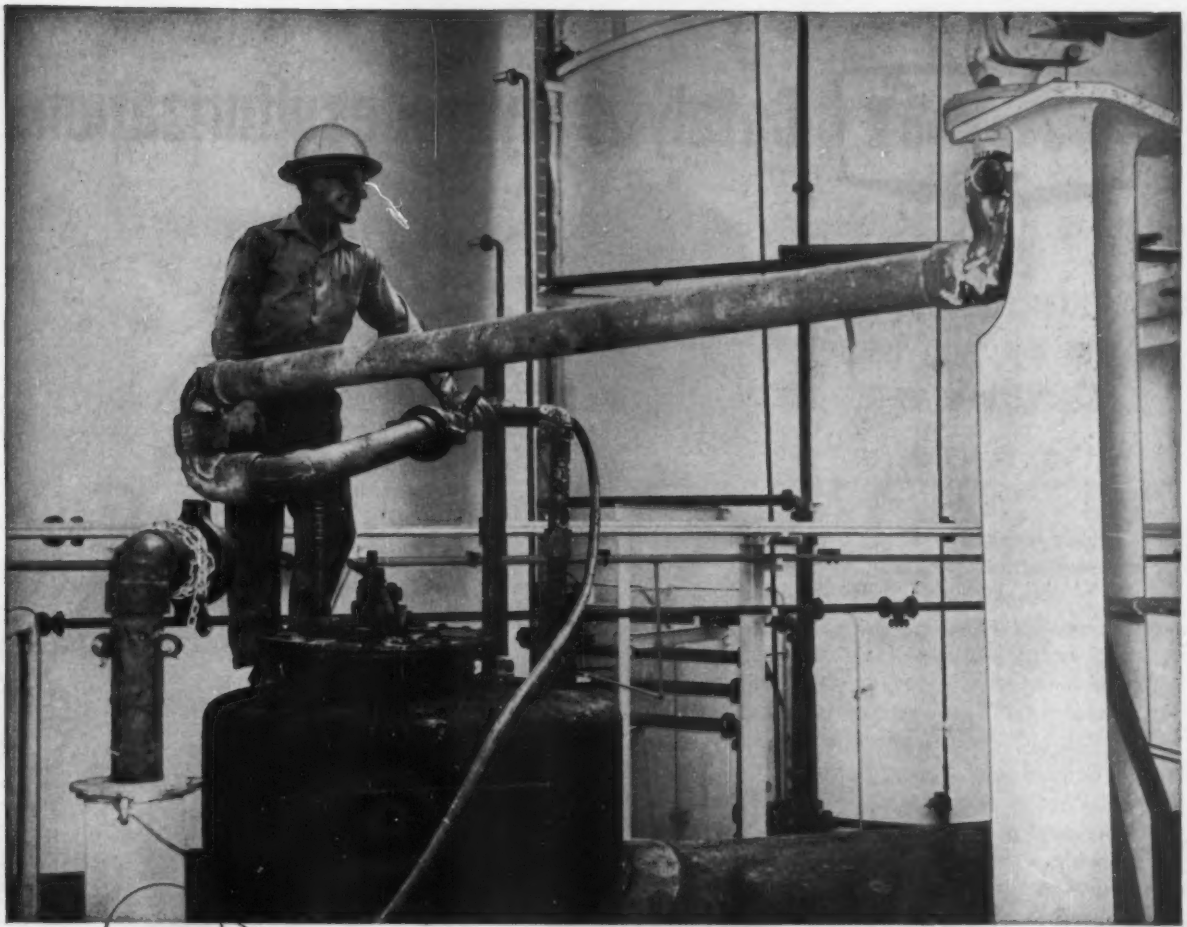
UNICOR is one of a number of UOP inhibitors and additives available to the refining industry. If you have a protection or preservation problem for product or transport facilities consult us.

PRODUCTS DEPARTMENT

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

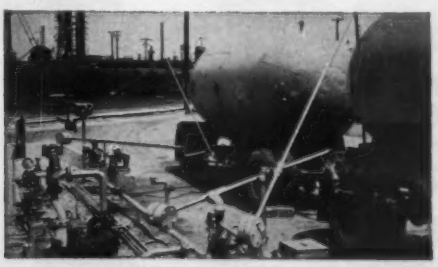


IN FLUID HANDLING—

CHIKSAN

LOADING ARMS

give hard-to-handle liquids a
SAFE SEND-OFF . . .



Chiksan Loading Arms deal with hard-to-handle corrosive chemicals, hydrocarbons, and other fluids and gases, speedily and safely, in all kinds of weather.

Chiksan Loading Arms, with their versatile ball-bearing swivel joints, combine unlimited flexibility with the safety and longevity of metal. With Chiksan there's never a problem of hazardous, often costly, line rupture loss. In fact, whatever fluid you are handling, you get longer life, spend less on maintenance, with Chiksan Loading Arms. Write for descriptive literature today.

Please address Dept. 54

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

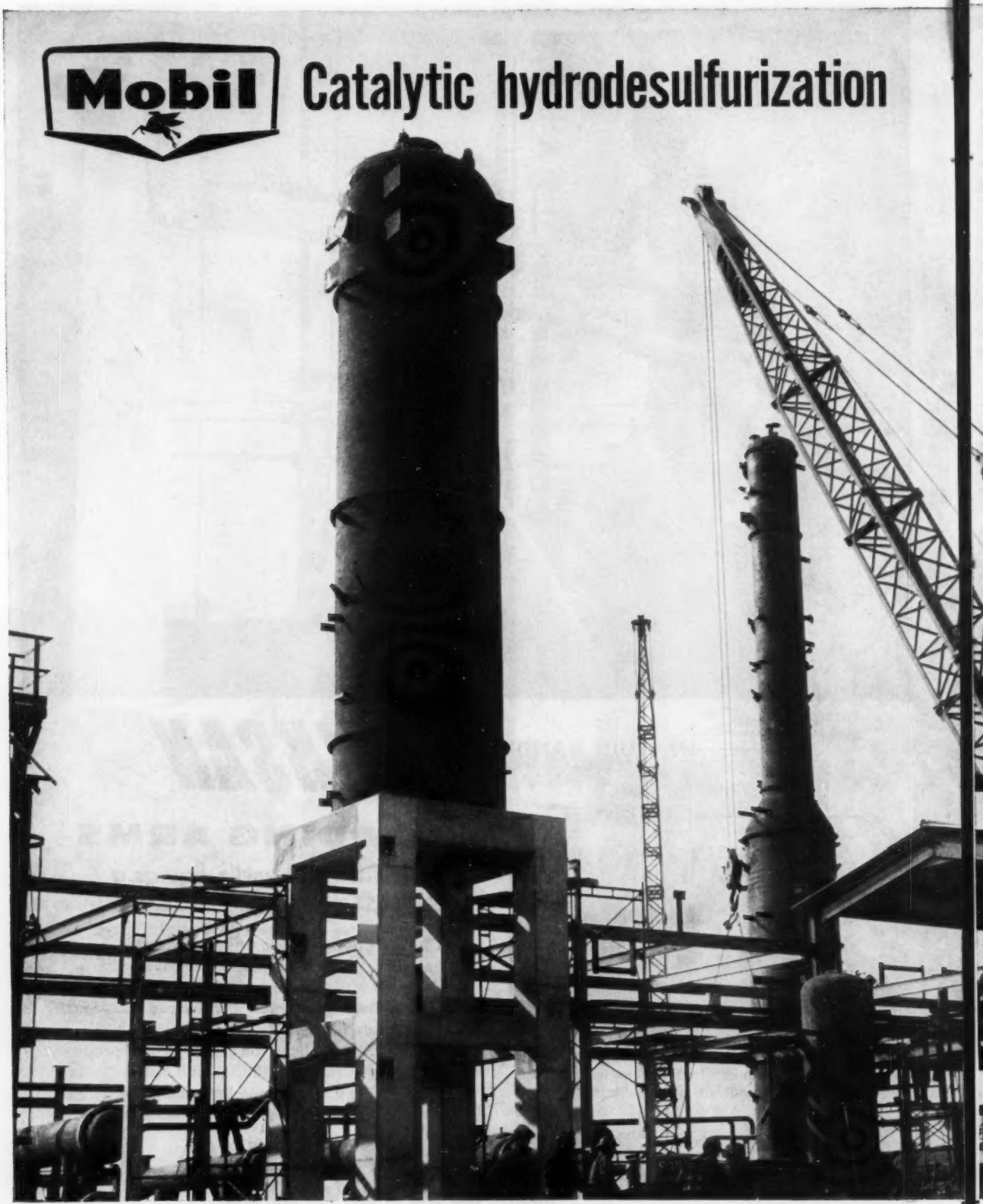
fmc

CHIKSAN

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

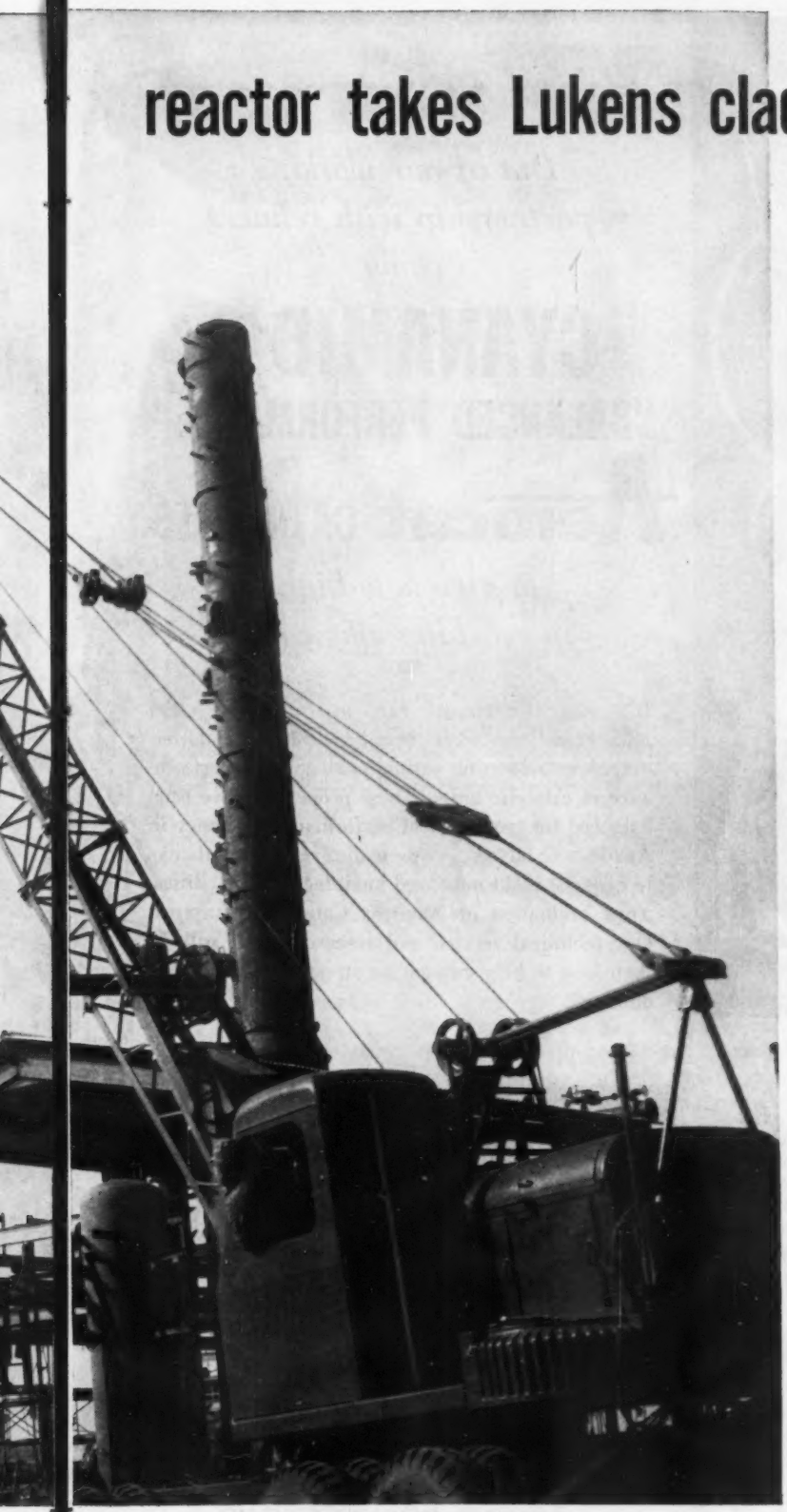
Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

Mobil Catalytic hydrodesulfurization



This is Lukens clad steel—not a lining, not a soldered-on surface, but a solid plate—one side corrosion resistant metal permanently bonded over-all to a rugged, economical backing steel.

reactor takes Lukens clad and alloy steels



CLAD STEEL STRIPPER, FLASH DRUM ALSO INSURE LONG-RUN ECONOMY, FREEDOM FROM MAINTENANCE

Designers and fabricators for Socony Mobil selected Lukens clad steel to combat corrosion by sulfur compounds . . . even at peak temperatures and pressures at which its new 22,000 bbl. catalytic hydrodesulfurization unit will operate at Paulsboro, N. J.

For the reactor vessel (left) and the top nine feet of the product stripper, Lukens stainless-clad type 321 was specified. ASME heads by Lukens are of the same materials —as is the flash drum.

Of equal importance, the backing of Lukens alloy—A-204 Gr. B carbon moly—resists the creep and hydrogen embrittlement which might otherwise result in this service. Typical temperatures range from 400° to 850°F., at pressures from 50 to 1500 psig. The installation is the first of many which Socony Mobil is planning for making No. 2 fuel oil a more efficient, better burning product.

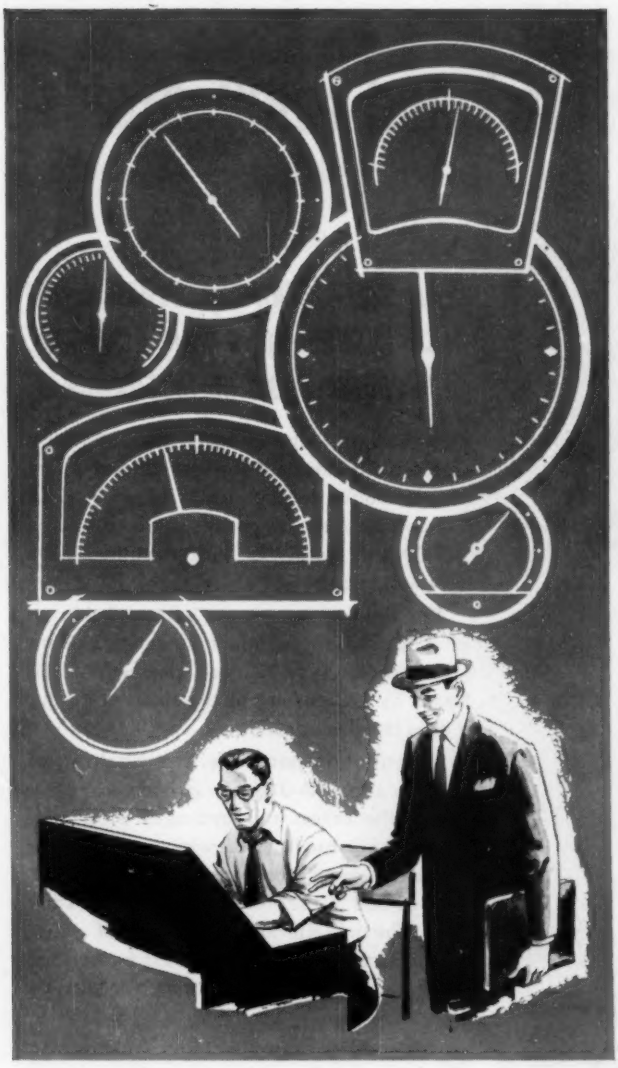
It is another example of how Lukens clad and alloy steels provide maintenance-free corrosion protection at high temperatures and pressures.

Ask your equipment builders, or write for the new **Clad Steel Equipment** bulletin, as well as information on alloy steels. Address Manager, Marketing Service, Room 968, Lukens Steel Company, Coatesville, Pa.

LUKENS®

Helping industry choose steels that fit the job

For more data on advertised products, use Readers' Service Cards, last page.

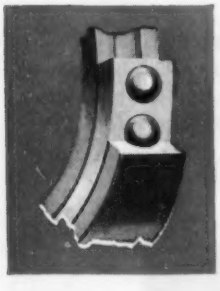


Out of our working partnership with refiners came

CYANAMID'S "BALANCED PERFORMANCE" Aerocat® CATALYSTS

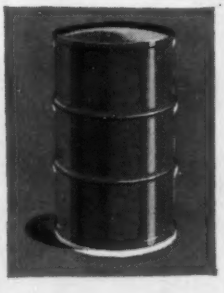
to give new highs in cracking efficiency!

It's *results* that count . . . and in working with the refining industry to get better yields, Cyanamid has pinpointed numerous variables, all affecting performance in catalytic units. These properties have been balanced for greatest field performance efficiency in AEROCAT Catalysts . . . now made even better, thanks to expanded and improved manufacturing facilities. Your evaluation of AEROCAT Catalysts is invited. Our technical service and research staffs will do their best to help you get on stream to greater productivity.



LUBE OIL ADDITIVES

The Cyanamid AEROLUBE® series of lube oil additives are formulated to meet the varying requirements of different base stocks. AEROLUBE 93-C, a concentrated inhibitor with superior anti-wear characteristics, rounds out our line of general purpose inhibitor-detergents.



HDS FOR HIGH SULFURS

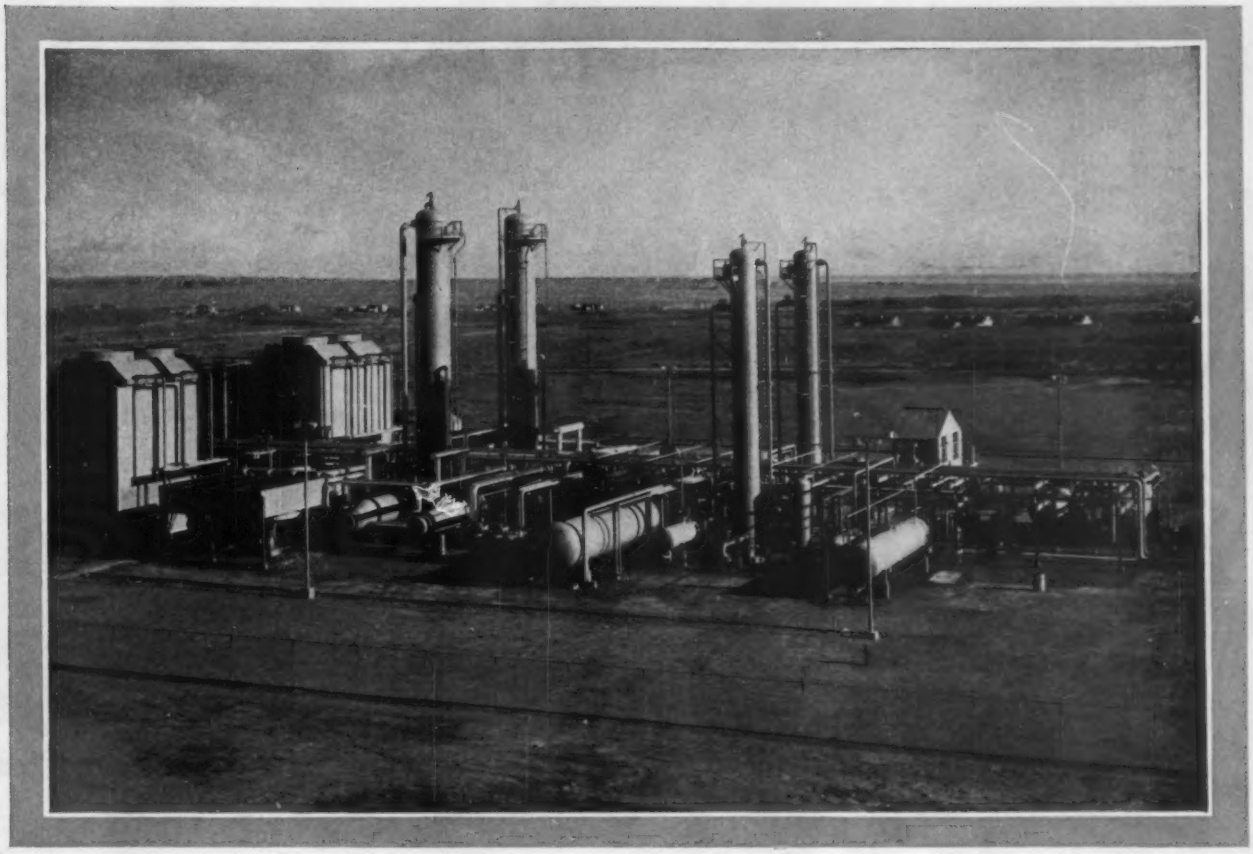
Conversion of high-sulfur fractions to H_2S is most effectively accomplished with Cyanamid AERO® HDS, cobalt-molybdena desulfurization catalysts. AERO HDS catalysts have highest available pore volume, excellent mechanical properties and low bulk densities.

The petroleum catalyst facilities of Cyanamid's research laboratories at Stamford, Connecticut, are unsurpassed in the petroleum industry. Through them, Cyanamid maintains its lead in the development of superior catalyst products.

CYANAMID

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal



Sui GAS STARTS TO KARACHI

This plant, the first of its kind in Asia, is located in the Sui Gas Field 350 miles northeast of Karachi in West Pakistan. It processes sour gas, removing sulphur compounds and water vapor, preparing the gas for transportation and consumption. It is a vital part of a project from which will accrue great economic advantage to Pakistan.

The work of Hudson included design, procurement of equipment, transportation, and erection using English, American and native labor.

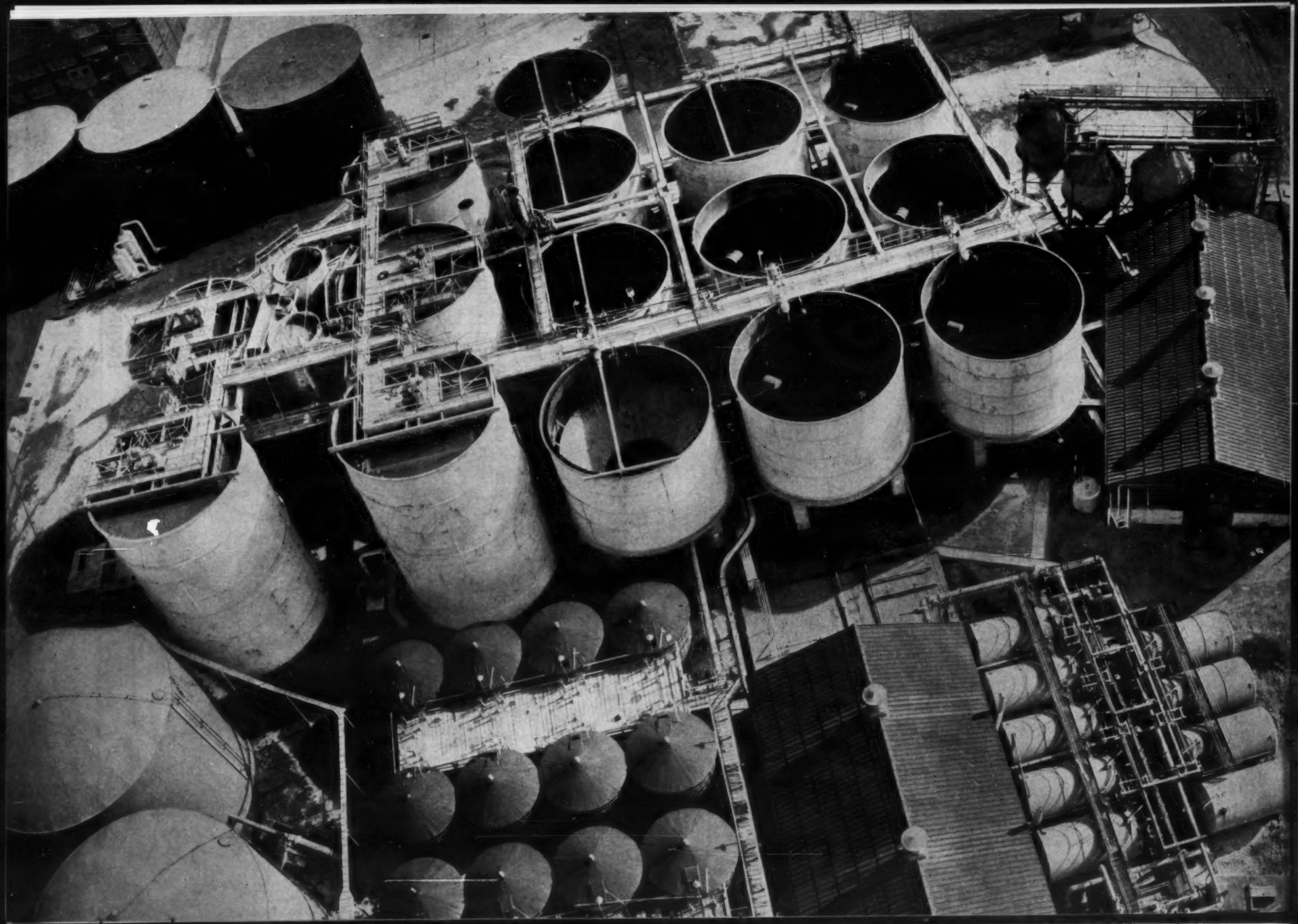
Despite the remoteness of the plant site, the rail terminus being 40 miles across the desert, and air temperatures as high as 125°F. in the shade, the plant was completed in 12 months from start of design work.

Hudson is proud to have collaborated with Pakistan Petroleum, Limited, and Sui Gas Transmission Corporation in the successful completion of this first project of its kind in Asia. The experience of Hudson gained in over 30 years in design and construction of oil and gas processing plants in the United States, Europe, Mexico and South America is available for any project large or small in any part of the world.

HUDSON

ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

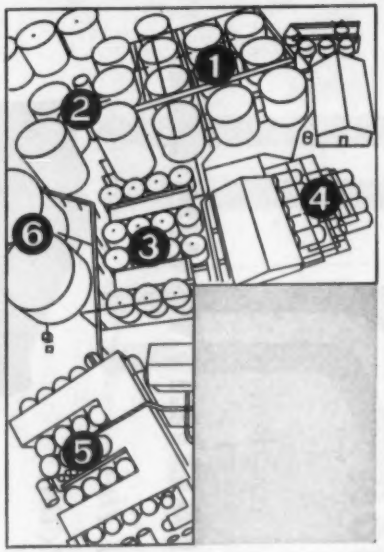


Water-tower view of PERMUTIT water-treatment equipment at Gulf States Utilities Company's Louisiana Power Station, North Baton Rouge, La. Engineered and constructed by Stone and Webster Engineering Corp.

12 million gallons of make-up per day

This station needs a *large volume* of water because it sells its steam to a refinery for process and requires 100% make-up. It needs *high-grade* water because it has adopted high-pressure boilers and turbines. It needs *efficient* treatment because it uses muddy Mississippi River water and well water with high solids and silica.

HERE'S HOW THIS 26-YEAR OLD PLANT HAS KEPT UP TO DATE *(see diagram):*



1. Original *batch coagulation and settling tanks.* Some are still used for secondary treatment of river water to reduce silica.

2. The 1931 roughing sedimentation tanks were converted to modern up-flow *Precipitators* in 1938 . . . cutting hardness 20%, turbidity 40%—and tripling capacity.

3. *Gravity filters* polish the clarified river water prior to softening.

4. Old Zeo-Dur® *zeolite softeners* were converted to new Zeo-Karb® exchanger in 1937 . . . boosting each unit's capacity 55%.

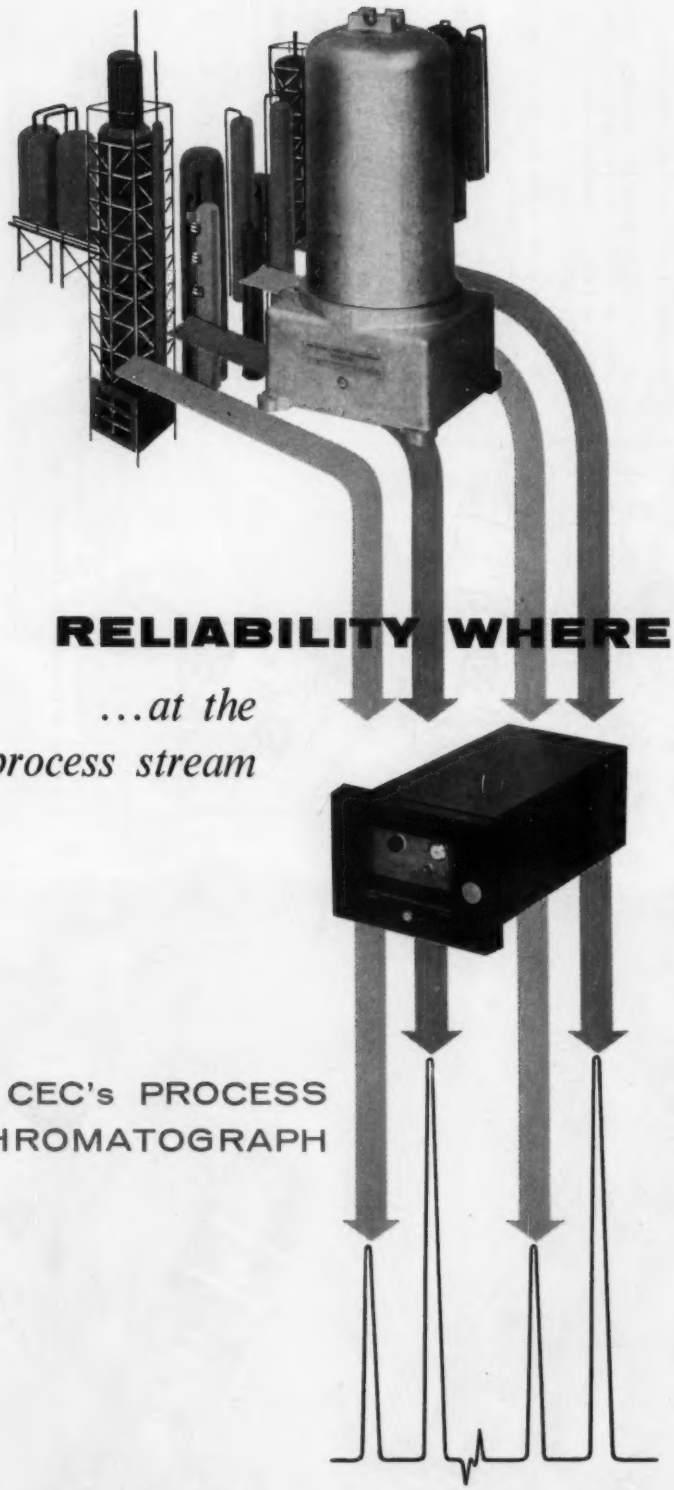
5. *Demineralizers* for new high-pressure boilers were added in 1955. They treat 3500 gpm, reduce dissolved solids of well water from 271 to under 2.0 ppm and silica from 25 to less than 0.1 ppm. Completely automatic PERMUTIT controls determine end-points, rinse, backwash and regenerate units and return them to service . . . even prepare regenerating solution.

6. *Tanks* store the high-quality, low-cost demineralized feedwater.

Whether you need one piece of water-treatment equipment . . . or acres of it, PERMUTIT has the know-how . . . earned by experience. This knowledge is at your service. Write The Permutit Company, Dept. PR-5 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®
WATER CONDITIONING
Equipment • Resins • Experience

Demineralizers • Zeolite and Hot-Process Softeners • Dealkalizers • Deaerating Heaters • Pressure and Gravity Filters • Chemical Feeders • Aerators • Blow-off equipment • CO_2 Indicating Recorders • Zeolites and Resins • Instrument Panels • Control Cubicles.



REMOTE OPERATION

Mounted at the sample point—operated from the control house—CEC's Type 26-202 Process Chromatograph gives you a simple, trouble-free system in two units. The Analyzer unit meets specifications for installation in Class I, Group D, Division 1 hazardous locations. From its remote location, the Control unit provides timing and control for all programming requirements.

RELIABILITY WHERE IT COUNTS

...at the process stream

CEC's PROCESS CHROMATOGRAPH

OUTSTANDING RELIABILITY

There are no vacuum tubes in the CEC Process Chromatograph. Its one power supply is completely transistorized. Accuracy of detector elements and calibrations can be checked at the Control unit.

SUPERIOR REPRODUCIBILITY

Precise regulation gives you these specific advantages: Sample volumes are reproducible to better than ±½%. Sample and column temperatures are held within ±1°F. Variations in the carrier gas flow-rate cannot exceed ±0.1%, and voltage regulation for the thermal conductivity cell is better than 0.05%.

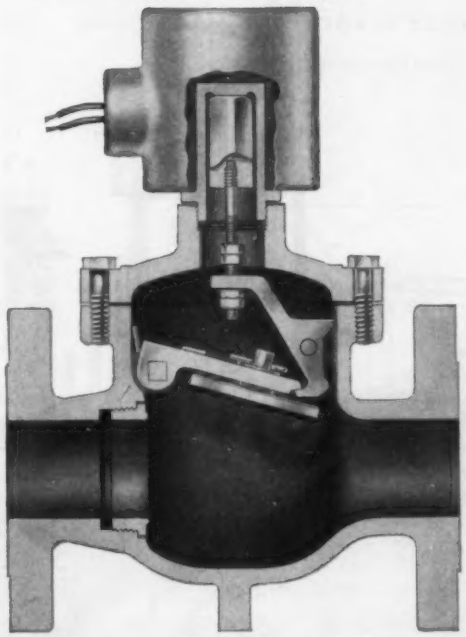
BEFORE YOU BUY any gas chromatograph, get acquainted with CEC's Process Chromatograph. For complete data and cost of this fast, inexpensive analyzer, contact your nearby CEC field office, or write for Bulletin CEC 1836-X7.

Consolidated Electrodynamics

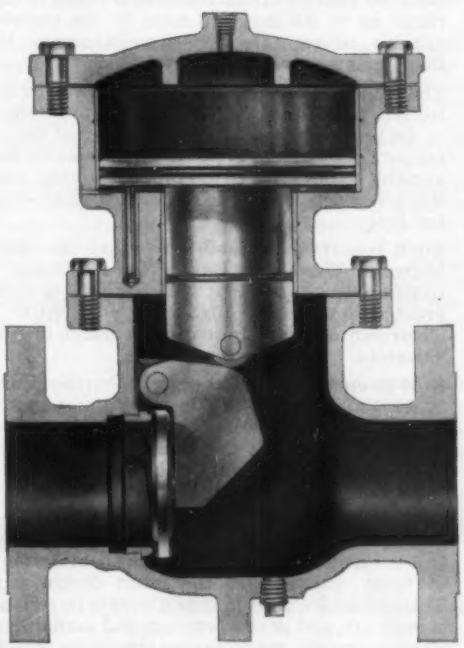
300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

Latch type valve closes instantly



Piston type valve opens instantly



Coppus Sentry® Valves Give Split-Second Action

Coppus Sentry Valves automatically protect property, materials, and processing with their quick, positive action. These are all full-flow valves for use on liquid and gas lines.

The latch-type valves stop flow instantly, automatically. They may be actuated by excess flow, overpressure, underpressure, overtemperature; or by energizing or de-energizing a solenoid.

These valves remain closed until manually reset. They are extremely popular in the chemical, petroleum and gas industry.

The piston type valve opens instantly. Opening and closing of this valve may be from any remote location — either automatically or manually. It is ideal for deluge systems.

Sizes run from 1½" to 8".

To get a more detailed story on this remarkable line of Coppus Sentry Valves, use the coupon to ask for Bulletin 500. Coppus Engineering Corp., Worcester 2, Mass.

ANOTHER COPPUS "BLUE RIBBON" PRODUCT

COPPUS ENGINEERING CORPORATION
418 Park Avenue, Worcester 2, Mass.

Please send Bulletin 500

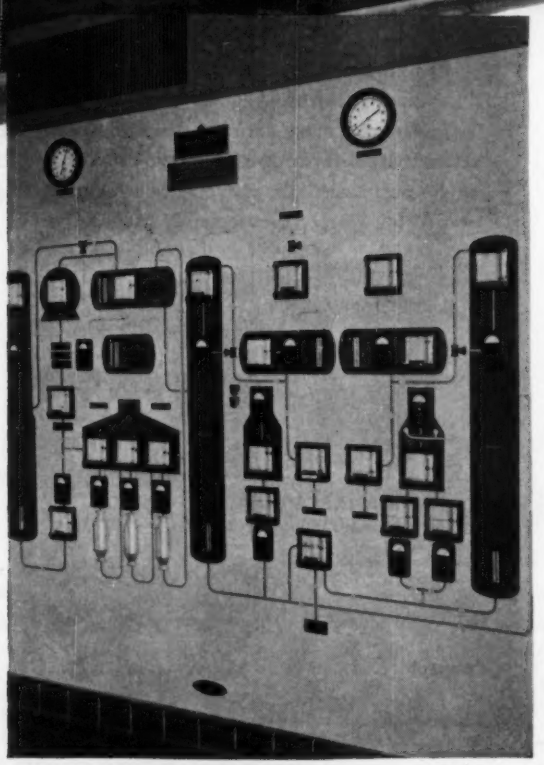
Name.....

Company .....

Address.....

For more data on advertised products, use Readers' Service Cards, last page.

THIS REFINERY GOES ELECTRONIC...



Pontiac Refining Company in Corpus Christi installed a new reformer in 1956 to produce 100+ octane gasoline. Because distances from the control house to the process range up to 800 feet and some of the variables were difficult to control, 'American-Microsen' Electronic Instruments were selected.

The control house contains 'American-Microsen' Controllers for pressures, flows, levels, and temperatures of the process materials at vital stages of the platforming process. Despite the long distances and fast-acting variables, the instruments provide control well within the tolerances required to produce high-octane motor fuel.

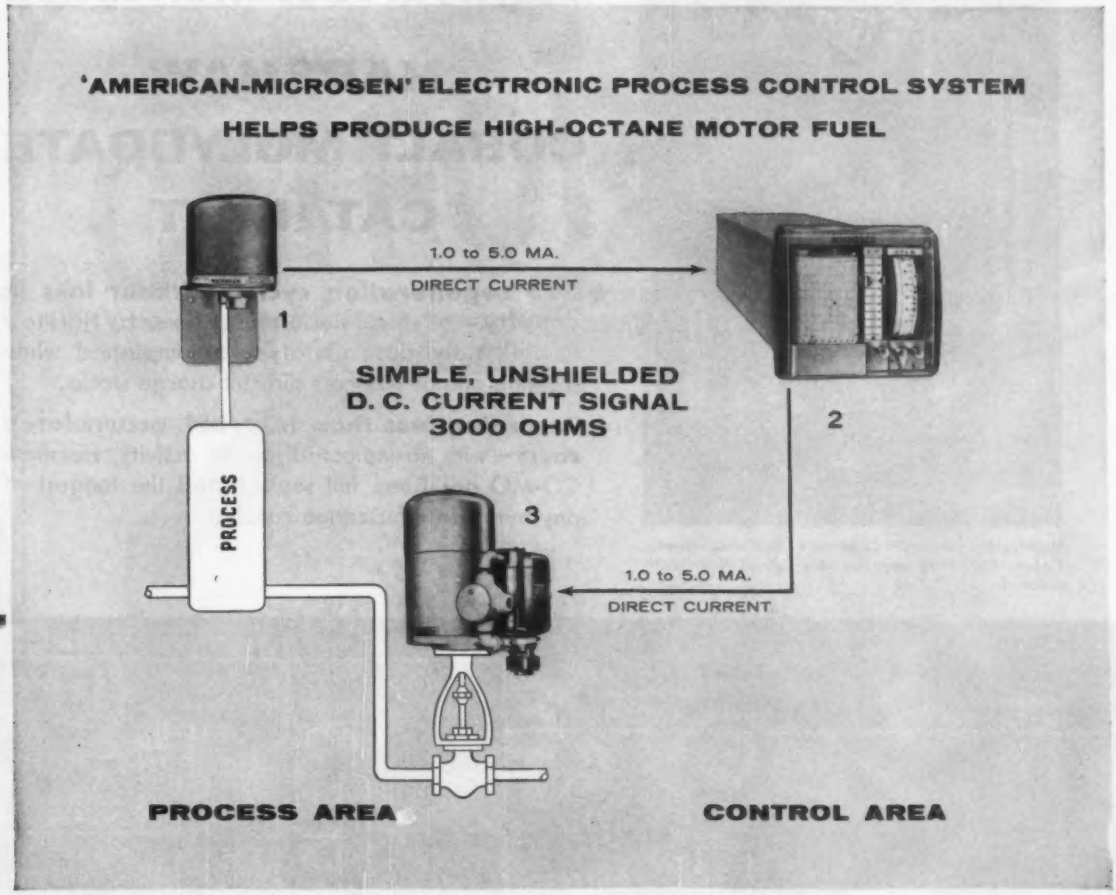
Such results are possible because the 'American-Microsen' System is completely electronic, with dc transmission signal that is insensitive to distances as great as 30 miles. The high speed and sensitivity of the electronic design improve the control of all process variables.

Now in operation over a year at Pontiac Refinery, the 'American-Microsen' System continues to give complete satisfaction — continues to help turn out high grade motor fuel. It is typical of many successful installations, and more and more companies are specifying the system for new plants as well as in modernizing existing processes.

Even though the electronics approach in process control is revolutionary, the 'American-Microsen' System of today incorporates the latest design techniques. Transistors are used for the ultimate in reliability and service life, and printed circuits and miniaturized components provide space-saving simplicity. The complete process control system now uses only three units.

For more data on advertised products, use Readers' Service Cards, last page.

the modern way to control process variables



1. **TRANSMITTER.** 'American-Microsen' transmitters are used for measuring pressure, temperature, differential pressure, liquid level, flow, and other process variables. The "Microsen" balance creates a stable dc signal for long distance transmission. Transmitters have a minimum of bearing pivots or linkages—assuring sensitivity and repeatability of measurement.

2. **CONTROLLER.** A single unit combines all functions of measuring and recording or indicating the input signal; producing the control signal; and allowing manual-automatic process operation. Separate plug-in chassis provides the following functions: A. Records or indicates process variable. Strip or card chart recorder chassis available. B. Produces proportional, reset and rate control actions to regulate the variable. All control settings are calibrated. C. Permits switching to manual operation during start-up or emergency conditions, with true "bumpless" transfer from manual to automatic control.

3. **ELECTRO-HYDRAULIC CONTROL VALVE OPERATOR.** A power unit with position feedback that operates slip-stem control valves. No compressed air is needed. Mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal percentage plugs, including valves of 4" stroke, and force available up to 3,250 lbs.

Where required, the 'American-Microsen' Electro-Pneumatic Valve Positioner or the Electro-Pneumatic Transducer can be supplied.

In automating your processes for higher product quality and greater operating economy, you want the better control and simplified servicing provided by the 'American-Microsen' Electronic Process Control System. We invite you to meet with one of our sales engineers to determine the best equipment for your service. Write for literature.

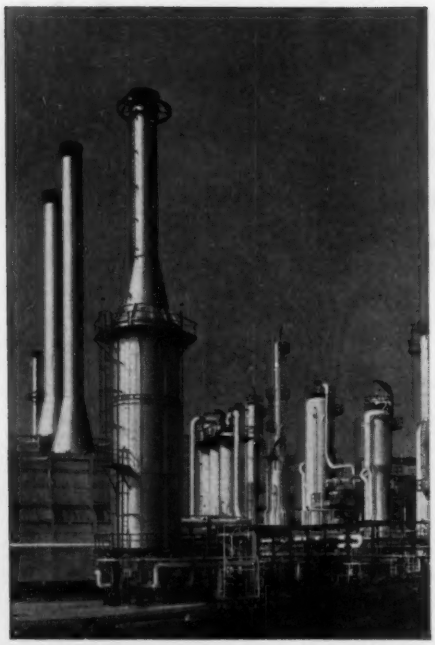
MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more data on advertised products, use Readers' Service Cards, last page.



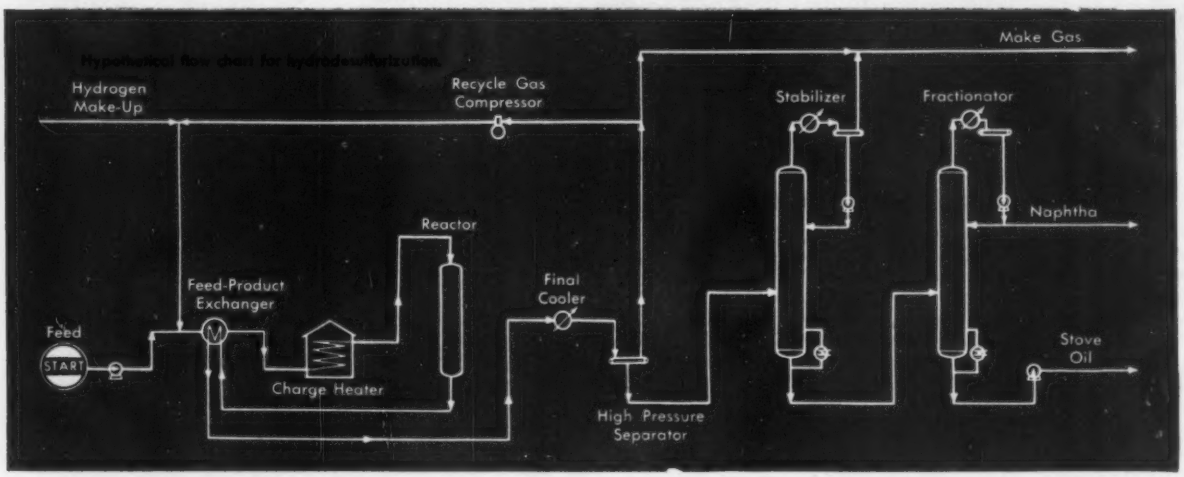
Unifining Unit, Union Oil Company of California refinery, Oleum, California uses Harshaw Cobalt Molybdate Catalyst.

For Hydrodesulfurization

HARSHAW COBALT MOLYBDATE CATALYST

★ **223 regeneration cycles without loss in activity**—a typical performance given by Harshaw Cobalt Molybdate Catalyst, accomplished while treating one of the most difficult charge stocks.

★ **Recording less than 1.0¢/bbl. accumulated costs**—with no indicated loss of activity, Harshaw CO-MO has been full scale tested the longest of any hydrodesulfurization catalyst.



Since you know the critical ingredient of any catalytic hydrogenation reaction is the *catalyst*, the above facts should prompt you to acquire complete details on this premium commodity in the field of catalytic hydrogenation. We shall be happy to point out the many specific advantages that come with using Harshaw Cobalt Molybdate Catalyst and discuss any specific application you may be considering.

Feel free to contact your nearest Harshaw office

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 E. 97th Street · Cleveland 6, Ohio

Chicago
Cincinnati
Cleveland
Detroit
Hastings-On-Hudson, New York
Houston
Los Angeles
Philadelphia
Pittsburgh

For more data on advertised products, use Readers' Service Cards, last page.

CATFORMING

YOUR LOW-COST KEY TO HIGH OCTANES

CATALYSTS — Specific type for your problems.

SELECTIVITY — Superior yield at high octanes.

STABILITY — High activity with long life.

DURABILITY — Tolerance for moisture and nitrogen.

REGENERATION — To extend normal life or recover from upsets.

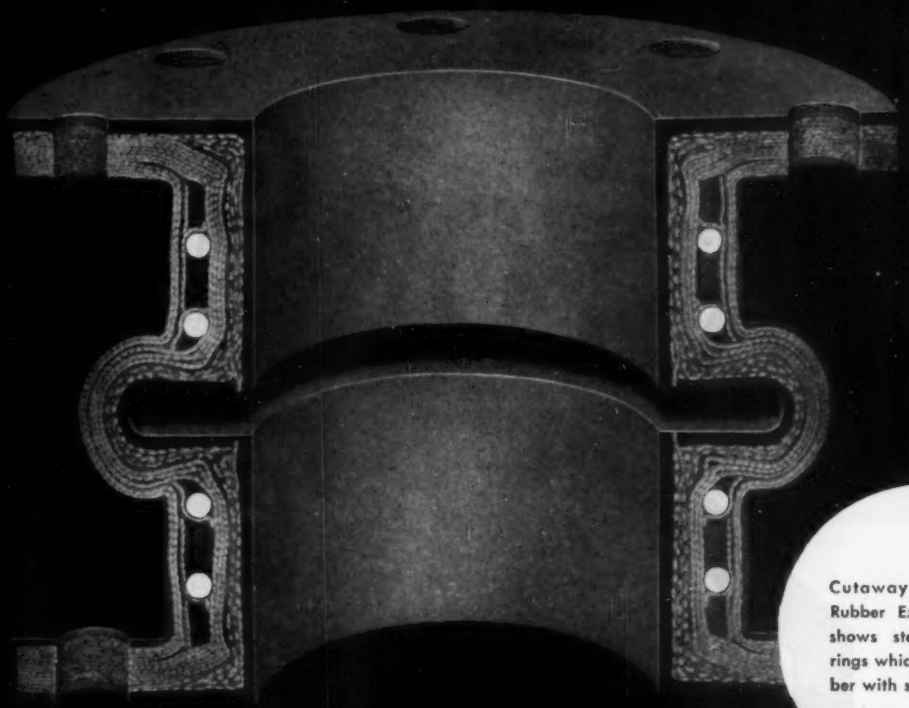
For further information on Catforming, write or wire The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

it's the **CATALYST** that counts

ATLANTIC

For more data on advertised products, use Readers' Service Cards, last page.

MORE OF THE GARLOCK 2,000



Cutaway of Garlock Rubber Expansion Joint shows steel reinforcing rings which vary in number with size of joint.

CORRECT VIBRATION, NOISE and FLANGE BREAKAGE...

GARLOCK RUBBER EXPANSION JOINTS are made from high-grade rubber, combined with plies of sturdy cotton duck and reinforced with steel rings. Practically any size or type expansion joint is available for service handling any liquid or gas. For example:

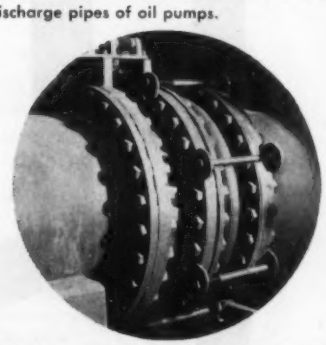
TYPE	USE
Rubber Expansion Joints (Spool-type, U-type, Tapered, Offset)	**Hot or cold water Mild acids or caustics Brine, air, exhaust steam**
Neoprene Expansion Joints	**Oil Other Petroleum Derivatives**
Teflon*-lined Rubber Expansion Joints All-Teflon Bellows-type Expansion Joints	**Strong acids and caustics Halogenated Solvents Pure Foods**

Rubber Expansion Joints are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The *only* complete line. That's why you get *unbiased* recommendations from your Garlock representative. Call him or write for Rubber Expansion Joint Folder AD-137.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

Garlock Expansion Joint on 2½" suction and discharge pipes of oil pumps.

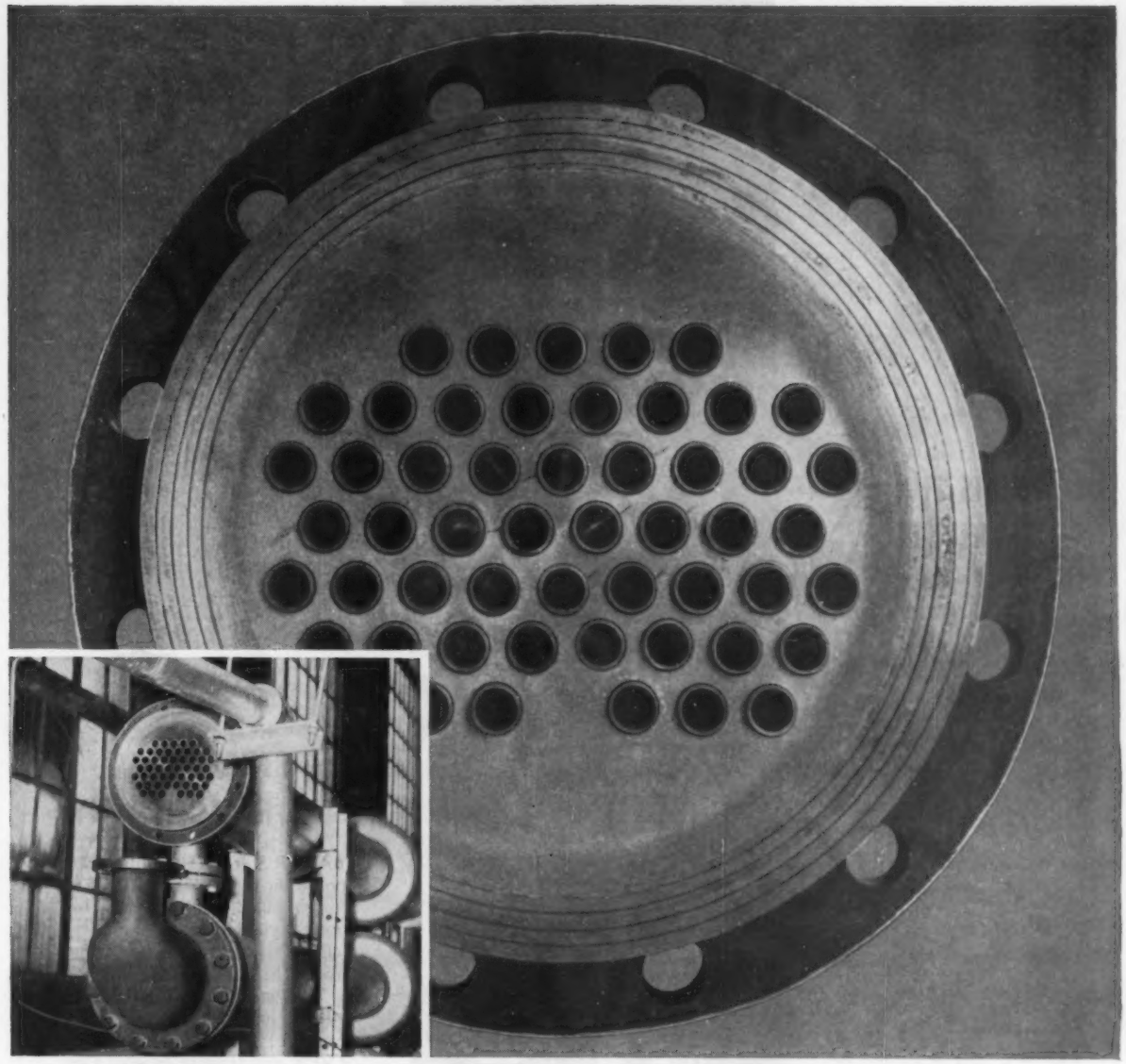


Garlock Expansion Joint on 30" pipe line connecting propeller-type circulating water pumps.

*DuPont Trademark

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products



Carpenter 7Mo Stainless Tubing

No corrosion . . . no pitting after 4 years of handling hot SO_2 gases and vapors

• The smooth, clean surfaces of the Carpenter 7Mo Stainless tubing in this 3-pass Relief Gas Cooler tell the whole story. Still like new after 4 years of carrying 8% SO_2 gases and vapors from the top of a sulphite digester at temperatures in excess of 200°F. No maintenance. No replacement worries. No costly downtime.

If you have a tough corrosion problem involving stress corrosion cracking and pitting, see what Carpenter 7Mo Stainless Tubing and Pipe can do to solve it for good. Call your Carpenter Distributor for service that satisfies.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

For more data on advertised products, use Readers' Service Cards, last page.

REGENERATES IN SITU!

THIS IS THE CATALYST

Sinclair-BAKER RD 150
Platinum Reforming Catalyst

THESE ARE THE REASONS WHY

BAKER'S RD 150 continues to prove the most efficient of all reforming catalysts—producing important yield increases at high octane levels and high octane reformates from low grade naphthas.

The long period of initial operation is unmatched by any other catalyst . . . and beyond that, *RD 150 is regenerative in situ!* Cost is sharply reduced to lowest level.

RD 150, a joint development of Baker & Co., Inc. and Sinclair Research Laboratories is unique. It is being used in highly successful production by many producers in this country and abroad. A Baker representative will be glad to give you detailed information, upon request.

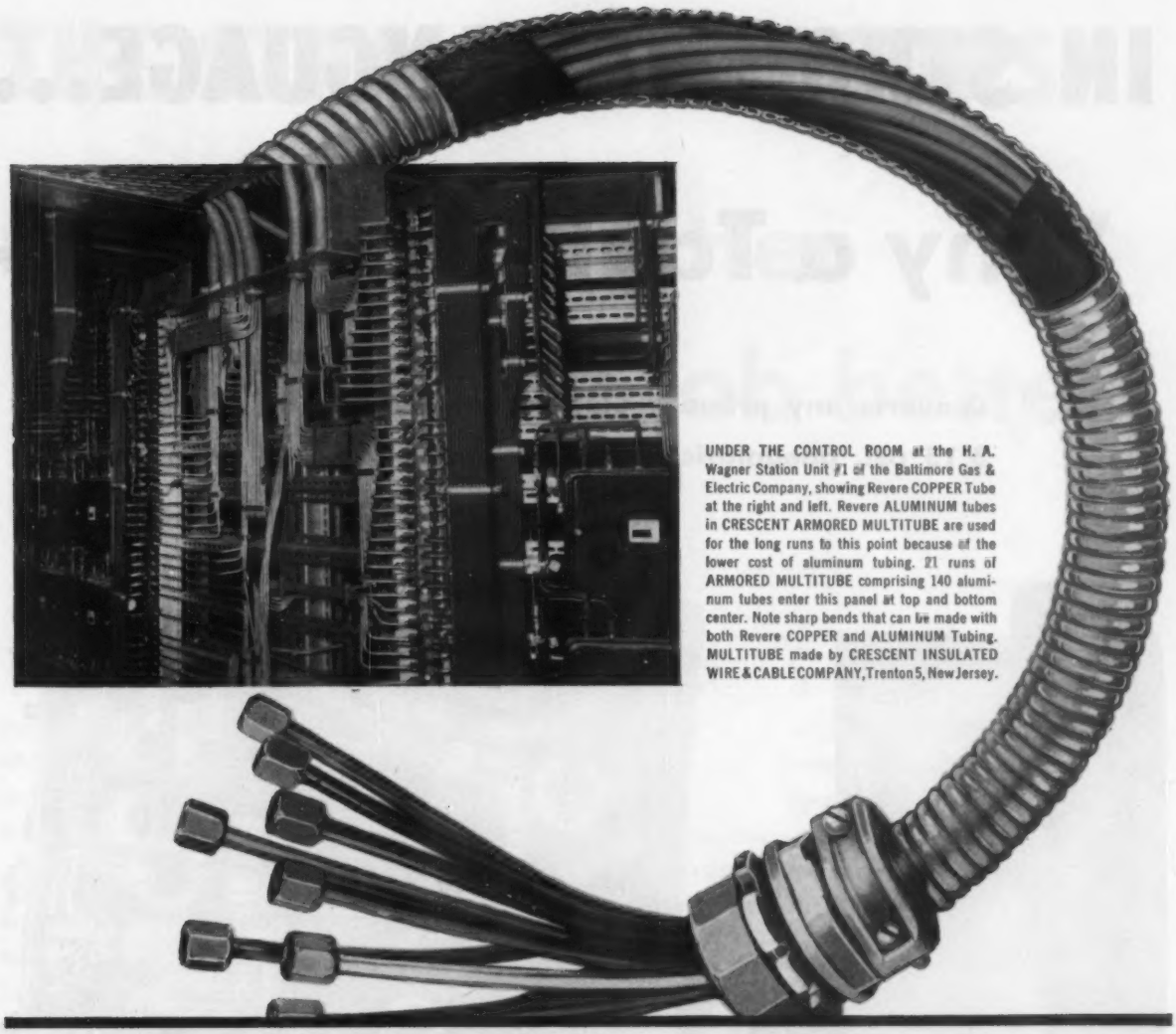
All data of confidential nature are of course treated accordingly.

BAKER & COMPANY, INC. CATALYSTS

BAKER & CO., INC.
113 ASTOR STREET, NEWARK 5, NEW JERSEY
NEW YORK • SAN FRANCISCO • LOS ANGELES • CHICAGO
ENGELHARD INDUSTRIES

SEND FOR BROCHURE
The Role Of Platinum Group Metals As Catalysts

THE HUB OF PLATINUM METALS RESEARCH



UNDER THE CONTROL ROOM at the H. A. Wagner Station Unit #1 of the Baltimore Gas & Electric Company, showing Revere COPPER Tube at the right and left. Revere ALUMINUM tubes in CRESCENT ARMORED MULTITUBE are used for the long runs to this point because of the lower cost of aluminum tubing. 21 runs of ARMORED MULTITUBE comprising 140 aluminum tubes enter this panel at top and bottom center. Note sharp bends that can be made with both Revere COPPER and ALUMINUM Tubing. MULTITUBE made by CRESCENT INSULATED WIRE & CABLE COMPANY, Trenton 5, New Jersey.

CRESCENT relies on REVERE

for dependable performance of its instrumentation and control tubing

REPORTS, "NOT ONE FAILURE."

The dependable performance of Revere Copper Tube in Crescent Armored Multitube*, ever since its inception, has led the CRESCENT INSULATED WIRE & CABLE COMPANY to fill its aluminum tube needs with Revere also.

In fact, Crescent, since it first started using Revere Copper Tube in 1953, reports not a single failure. And that's mighty important in instrumentation and control tubing service where utilities, chemical processing, petroleum, paper and similar industries can't afford the luxury of process failures.

Crescent Multitube, using either Revere Copper or Aluminum Tube, or both in combination, offers a completely protected installation for permanence, lower original installation cost, lower maintenance and a saving of time, space and money.

Crescent Armored Multitube consists of a group of Revere Copper or Aluminum Tubes, twisted together in cable form, protected by a flexible interlocked galvanized steel armor. Constructions are available employing plastic sheaths in combination with the armor for corrosive locations. Section of cabled tube pictured shows how Copper or Aluminum Tubes are encased inside the Armored Multitube. As many as 37 tubes of ¼" OD can be cabled in lengths up to 1,000 ft.

For details on Multitube write Crescent and for uniform quality copper and aluminum tube, speedily delivered, see the nearest Revere Sales Office.

*Reg. Trademark

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

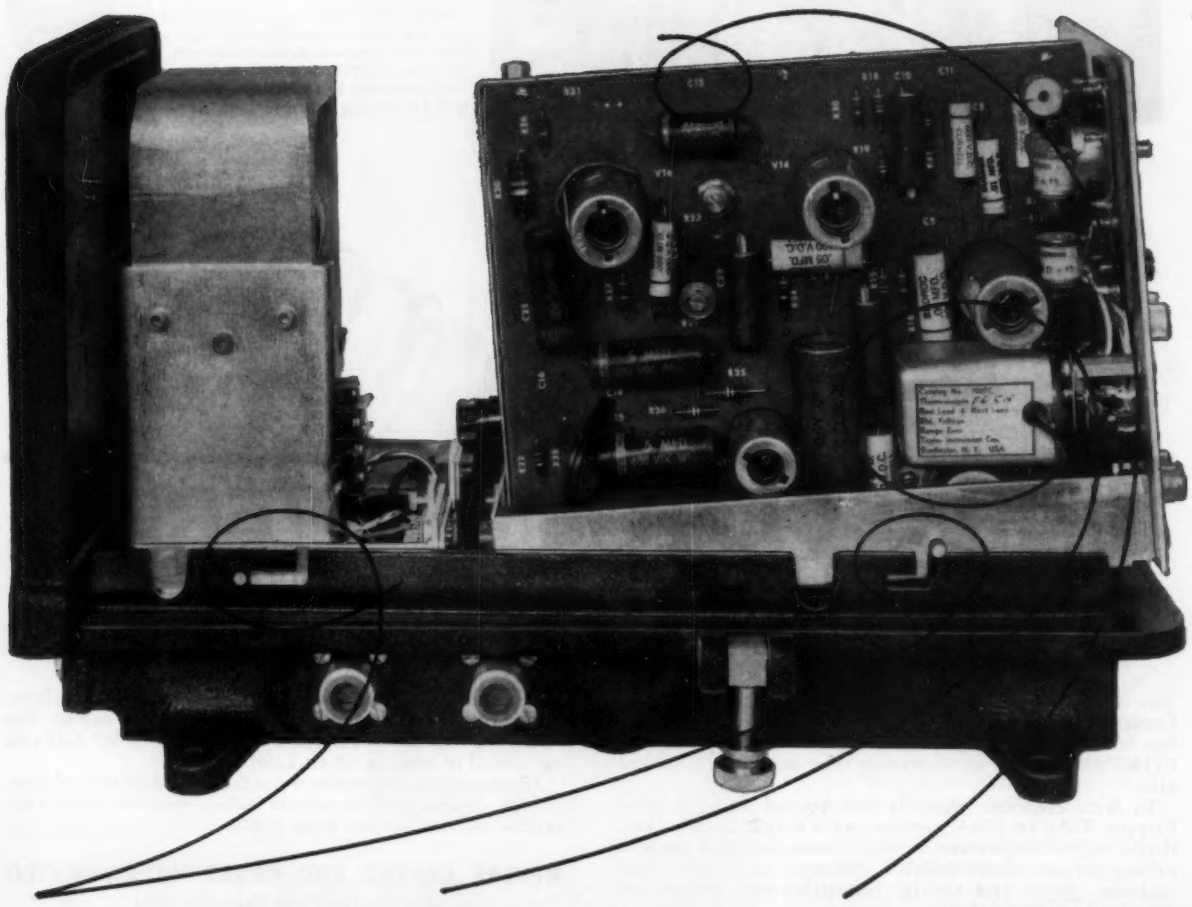
230 Park Avenue, New York 17, N. Y.

Mills: Rome, N. Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

IN STRAIGHT LANGUAGE...

Why a Taylor Potentio-

Converts any primary electrical signal into a 3-15 psi. pneumatic output for controllers and receivers



PLUG IN the Transducer and the Amplifier—an exclusive with Taylor! Gives you quick, easy removal for service with minimum instrument down-time . . . means that checking can be done efficiently in the shop where full facilities are available.

PLUG IN CANS for simple service changes. Adapts quickly for use with different primary elements by simply plugging in the corresponding service "can". Note—for thermocouple applications cold junction compensation is provided in the plug-in can.

PERMANENT IDENTIFICATION of all component parts because numbers are engraved on the phenolic board. It's impossible to erase these numbers in any way, so you can always locate all the electrical components quickly for ease of servicing.

THE STRAIGHT REASONS

meter Transmitter will do the job better!

1 The unit is continuously standardized automatically. It assures complete electronic balance and permits optimum response adjustments. There are no slide wires, no batteries, no moving parts.

2 Easy continuous adjustment of range span and zero suppression—exclusive Taylor vernier adjustment gives exceptionally fine accuracy in calibration of the unit. You can completely change the range and zero suppression as plant conditions demand—only need one instrument as a spare.

3 Both electronic and pneumatic units plug in—you get easy servicing and separate calibration. With both electric and pneumatic output signals available, this instrument is exceptionally versatile.

4 Modern printed circuits insure uniform performance because there's no variation between units. Every electrical component is identified by engraved numbers on the phenolic board—another simplification for the maintenance technician.

NOTE: 701T Transducer can be purchased separately with its own individual zero and range adjustments.

5 Quickly adapted for use for different primary elements because you just plug in the corresponding service "can". (See opposite page).

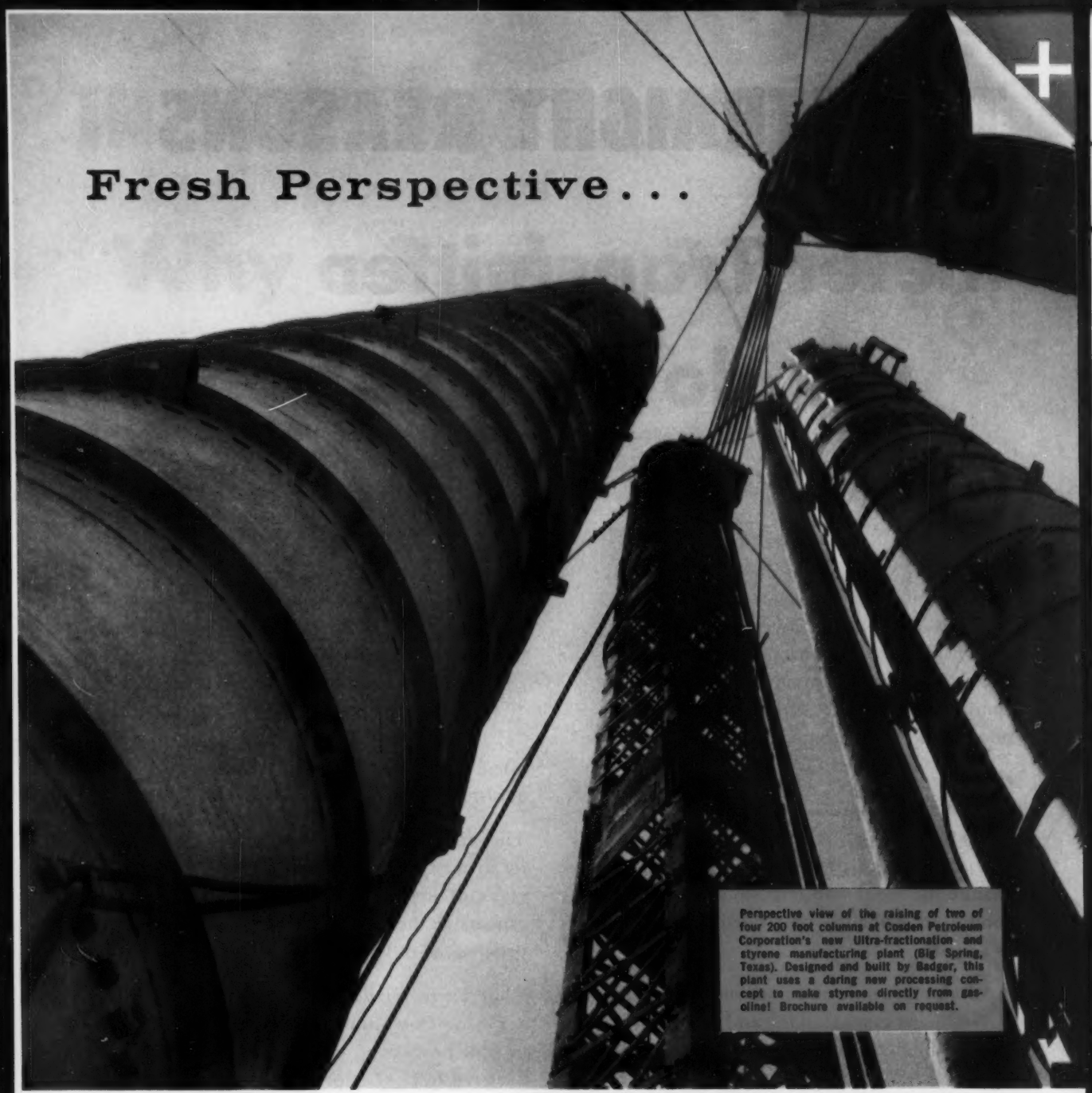
"Most ingenious . . . and most practical"—that's what instrument men say about this important addition to the three-part TRANSET* System.

That this ingenious instrument works so well in so many places is another reflection of the years of experience of Taylor instrument engineers in helping solve the problems of the processing industries.

Your Taylor Field Engineer can suggest where a Taylor Potentiometer Transmitter will help in your processing picture. And write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

*Reg. U.S. Pat. Off.

Taylor Instruments
MEAN
ACCURACY FIRST
VISION · INGENUITY · DEPENDABILITY



Perspective view of the raising of two of four 200 foot columns at Cosden Petroleum Corporation's new Ultra-fractionation and styrene manufacturing plant (Big Spring, Texas). Designed and built by Badger, this plant uses a daring new processing concept to make styrene directly from gasoline! Brochure available on request.

+ The ability to put engineering problems in a *fresh perspective* — to subject them to a point of view that leads to new solutions — is at the root of Badger accomplishments like these:

. . . a commercially practical method of separating ethylbenzene from gasoline by Ultra-fractionation.

. . . a continuous process for producing sodium-hydrogen compounds.

. . . the successful application of a new process for deriving high quality light oils from coal — without acid treating.

An intangible that has been called "The Precious Plus behind a Badger blueprint," this refreshing ability to apply *new* thinking to difficult engineering problems has produced two important results:

1. Top petroleum and chemical processors are securing better processes, more economical plants.

2. Badger has become one of the world's fastest growing contract engineering firms.

Whether your project is commonplace or complex, calling in Badger is the first step toward securing the precious advantages that can come only from taking a *fresh perspective.*

Badger's Key Man Operating Policy: "The Badger man who submits your proposal is always a Badger principal — always the Key Man responsible for the execution of your job."

BADGER

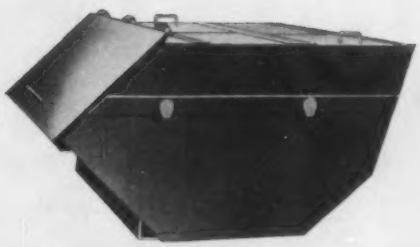
MANUFACTURING COMPANY

230 Bent St., Cambridge, Mass.
New York, N.Y. • Houston, Texas
IN EUROPE: Badger-Comprimo N.V., The Hague
Badger-Comprimo S.A., Antwerp

ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS

DISASTROUS FIRES

you can help prevent them by storing and handling materials in fire-resistant LOAD LUGGER CONTAINERS

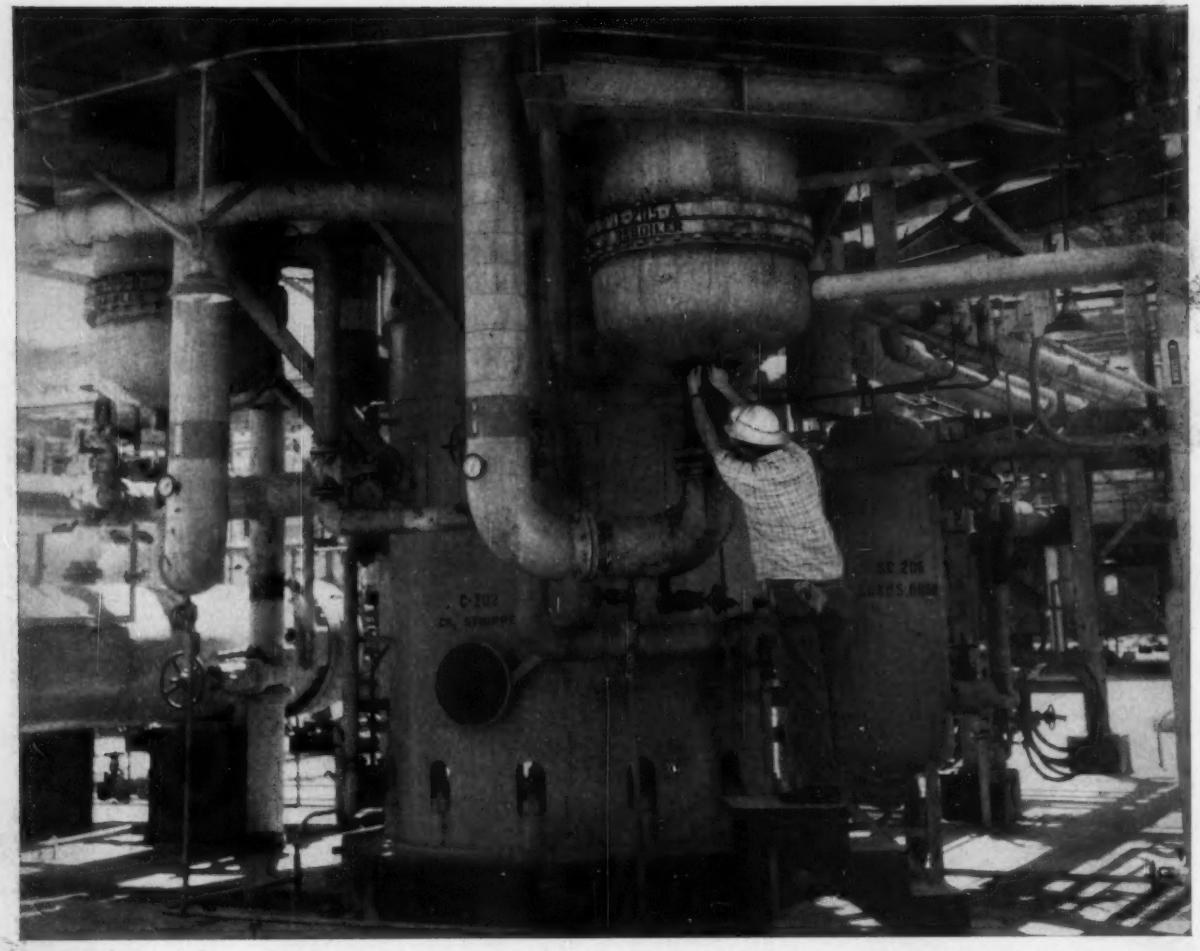


...another advantage of the modern LOAD LUGGER system

Fire is confined within the steel container, is easy to control and extinguish, often doesn't spread beyond the smoldering stage. The container, fire and all, can be readily moved to a safe area. Consider this Load Lugger advantage when you investigate materials handling equipment. Write today for full information about the Load Lugger system—Load Lugger equipped truck servicing dozens of patented Load Lugger containers. You'll be money ahead.

LOAD LUGGER BW

LOAD LUGGER, Ingersoll KALAMAZOO DIVISION
BORG-WARNER CORPORATION
1895 North Pitcher Street, Kalamazoo, Michigan, Telephone Fireside 5-3501
EXPORT SALES: BORG-WARNER INTERNATIONAL CORPORATION, CHICAGO



Monel-protected . . . Reboilers on this column used for stripping CO_2 from monoethanolamine solutions at a Shell Chemical anhydrous ammonia plant contain Monel alloy tubes. Tubes have shown no significant corrosion in two years.

Little to do but turn the valves when MEA reboilers have Monel bundles

Shell Chemical checks CO_2 corrosion . . . descales only once in two years

This workman never had it so good.

Used to spend a good deal of time with the two reboilers on this column which strips CO_2 from "fat" monoethanolamine solutions. First he would dismantle one. Descale. Hook up again. Before long it was the other's turn. Every three to six months new tubes had to go in.

But that all stopped in 1954

Shell Chemical put in Monel* nickel-copper alloy tube bundles.

Since then, the reboilers have been descaled but once. What's more, deposits appear to contain no corrosion products . . . just stream precipitates. Tubes look like new . . . have never been replaced.

Take a leaf out of Shell Chemical's book

Inco's Corrosion Engineering Section will be glad to help you check into corrosive conditions within your MEA reboilers.

If Monel alloy is indicated for the tubes . . . and there's a good chance that it will be . . . put it in!

Then relax. Look at the meters. Turn a valve once in a while.

*Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Monel . . . *for minimum maintenance*

DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

MAY 1957

NEW DIRECTOR OF SALES FOR PETROLEUM CHEMICALS

W. SAM CARPENTER, III, has been appointed to succeed David H. Conklin as director of sales of the DuPont Petroleum Chemicals Division. Mr. Carpenter was promoted to this position from that of assistant director of sales.

Mr. Conklin has been named managing director of the DuPont Company (United Kingdom) Limited. He plans to make his home in London next year.

Alfred R. Mullis, formerly Eastern regional manager of the Petroleum Chemicals Division, replaces Mr. Carpenter as assistant director of sales.

Mr. Carpenter came to the Petroleum Chemicals Division in 1955 from the Cellulosics Division of the Textile Fibers Department where he was director of manufacturing. Prior to joining Textile Fibers, he had been manager of the DuPont Industrial Engineering Division. He joined the DuPont Company in 1938 as an industrial engineer.

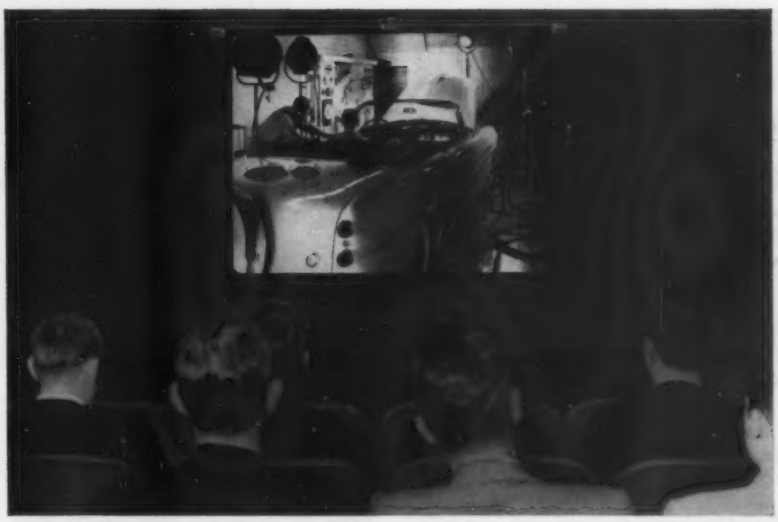
In 1944 and 1945, he was active in the construction and operation of the government's atomic energy project at Hanford, Washington. Mr. Carpenter received his chemical engineering degree from Princeton University.

Mr. Conklin, who came to DuPont as a sales-service representative from Ingersoll-Rand, has been with the Petroleum Chemicals Division since it was organized. He was promoted to West Coast regional manager, then to sales pro-

OVER

Refiners can use these marketing services profitably

The DuPont Petroleum Chemicals Division offers a wide range of marketing aids and services. Many of these are ideal for dealer meeting programs. Others can be profitably used in promotion campaigns. Here is a brief résumé of the DuPont marketing services now available to you:



MOVIES available from DuPont make ideal program material for your dealer meetings.

"When the customer says 'KNOCK'" is a DuPont sponsored, full-color motion picture to instruct dealers on how to handle, in a salesmanlike way, customer complaints about gasoline quality.

This is but one of a series of films. They cover subjects ranging from gasoline quality, just mentioned, to an explanation of the benefits to the public of the percentage depletion allowance. Folders describing these films in detail, along with information on borrowing them, can be obtained from any of our sales offices.

Special demonstration equipment

To help refiners explain quality features of their products clearly and graphically, we have designed and built a number of special demonstration devices. The latest is a machine for showing how carburetor icing occurs and can be prevented with DuPont dimethyl formamide.

I. T. Rosenlund is shown here operating the de-icing demonstration.

This equipment is ideal for pointing up convincingly your product-quality

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DUPONT *Petroleum Chemicals* NEWS

Du Pont equipment and experience usually available to refiners

REFINER:

Yes, we anticipated that fuel injection systems in cars would raise some new problems in gasoline blending . . .

DU PONT REPRESENTATIVE:

That's right, and our Petroleum Laboratory has already been making road tests using special fuels in injection systems.

REFINER:

Is that so — then maybe you people already have some data we could use?

DU PONT REPRESENTATIVE:

We're accumulating it gradually. We have three fuel-injection cars in our Petroleum Lab.

REFINER:

Good! I hope we can get the results of your investigations.

DU PONT REPRESENTATIVE:

I'll see that you do. As our road tests develop further facts we'll keep you informed.

CONTINUED ***Marketing Services***

features to dealer and customer groups.

We can also supply you with a great variety of booklets and visual presentations on gasoline and motor oil quality, customer relations, station services, and other subjects. You can obtain these in large quantities at cost, or at no charge if you'd like only a few copies.

Continuing market surveys

When planning promotion campaigns, you can make use of the findings of our several extensive surveys of customer buying habits and service station operations.

These cover such subjects as the factors influencing a dealer's success, why motorists buy the brands they do, how they select service stations, and which factors in gasoline-brand advertising influence them most.

A report on our latest — and perhaps most important — survey will be finished by mid-summer. The results will be made available to all marketing executives in the oil industry.

Public relations aids

Our newest presentation emphasizes the importance, to everyone, of the petroleum industry — "A 'Brief' Case for Business." It is a lightweight kit which enables you to tell a forceful public relations story in a dramatic way. This kit was conceived and developed by Du Pont and is made available to oil companies through the Oil Information Committee of API, or through your Du Pont representative.

You can probably save time and money by supplementing your own promotion program with these useful aids, adapting them to your own purposes. Any of our Petroleum Chemicals Division representatives or sales offices will be glad to give you more information on them.

continued middle next column

H. C. Thompson displays the "Brief" case public relations kit.

CONTINUED ***New Director of Sales***

motion manager, later assistant director and then director of sales.

Conklin a Navy veteran

During World War II, Mr. Conklin as Commander U. S. Navy, was on active duty 5 years—most of the time in the North Atlantic. He was awarded the Order of the British Empire.

Mullis former sales representative

Alfred R. Mullis joined the Du Pont Company in 1947 as a sales representative in the Gulf Coast Region. He was appointed regional manager there in 1951. The following year he went to New York as Eastern regional manager.

After graduating from Rice Institute with a chemical engineering degree, Mr. Mullis was associated with the Humble Oil and Refining Company in research and development work. While an officer in the Navy from 1942 to 1946, he specialized in petroleum inspection work.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630
Cleveland 15—25 Prospect Ave. . . . SUperior 1-1363
Denver 2—510 Mile High Center Bldg. . AComa 2-2347
Houston 2—
705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 5-1691
New York 20—
1270 Ave. of the Americas . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . . EXbrook 2-6230
Seattle 3—4003 Aurora Ave. . . . . MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
In Other Countries—Petroleum Chemicals Division, Export Sales, 7496 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

A-4310

Printed in U. S. A.

Here's the Industry's Most Advanced Inert Gas Generator

HERE's the packaged inert generator industry has been waiting for. It comes complete, ready to hook "on line" and go to work. The desirable single burner design eliminates control problems, assures constant analysis gas whether operating at 20% or 100% of capacity. Any gaseous fuel or light fuel oil can be safely used, including pure hydrogen for the production of nitrogen. Combustion chamber and heat exchanger are of stainless steel—designed to reduce surface temperatures well below safety margin.

Electrical circuits permit automatic purge and safe start in accordance with Factory Mutual and Insurance Underwriters codes.

But we've only scratched the surface—be sure you get all the facts on the advanced Gas Atmospheres packaged units before you buy.

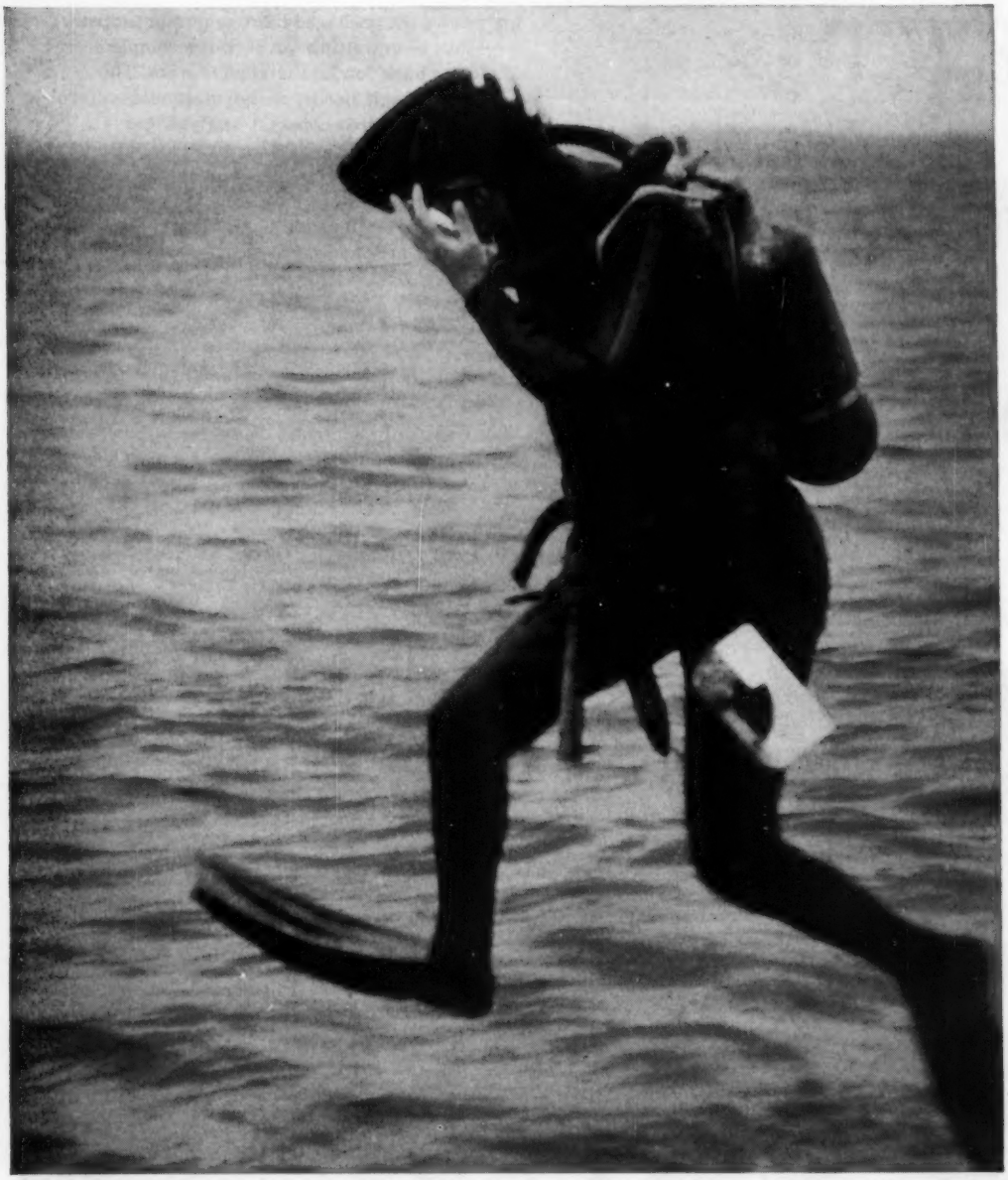
Inert gas units available from 250 CFH to 150,000 CFH.

End view shows modern control and simplicity of single burner construction.

gas Atmospheres, inc

equipment for producing industrial gases

20011 WEST LAKE ROAD CLEVELAND 16, OHIO



MILLION DOLLAR DIVE...

OFF CALIFORNIA a geologist-frogman dives deep to the ocean floor in search of petroleum-bearing rock for Texaco.

If successful, America's oil reserves may be richer by millions of barrels.

On five continents Texaco oil explorers are using aerial surveys, artificial earthquakes, soil analysis and other methods to locate more oil to satisfy the ever-increasing world demand.

This work is just one phase of Texaco's multi-million dollar program to produce more and finer petroleum products for the transportation, rubber, petrochemicals and plastics industries... an investment in the future.

THE TEXAS COMPANY

Progress . . . at your service

...more quality proved POWELL VALVES

Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted Gland type. Gear Operated. Sizes 6" to 12".

Fig. 2467—Small Stainless Steel Gate Valve for 300 Pounds W.P. Outside screw stem and bolted yoke.

Fig. 86190—Steel "LPG" Globe Valve for 400 W.O.G. For services that demand the use of Steel Valves.

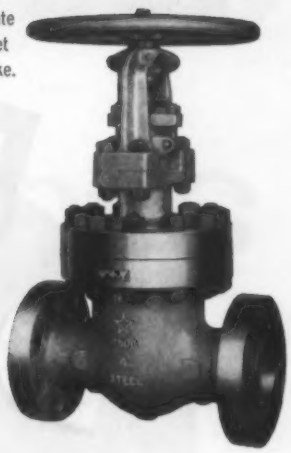


Fig. 1303—1500-Pound Steel Gate Valve with bolted flanged bonnet and outside screw stem and yoke.

made with quality proved materials

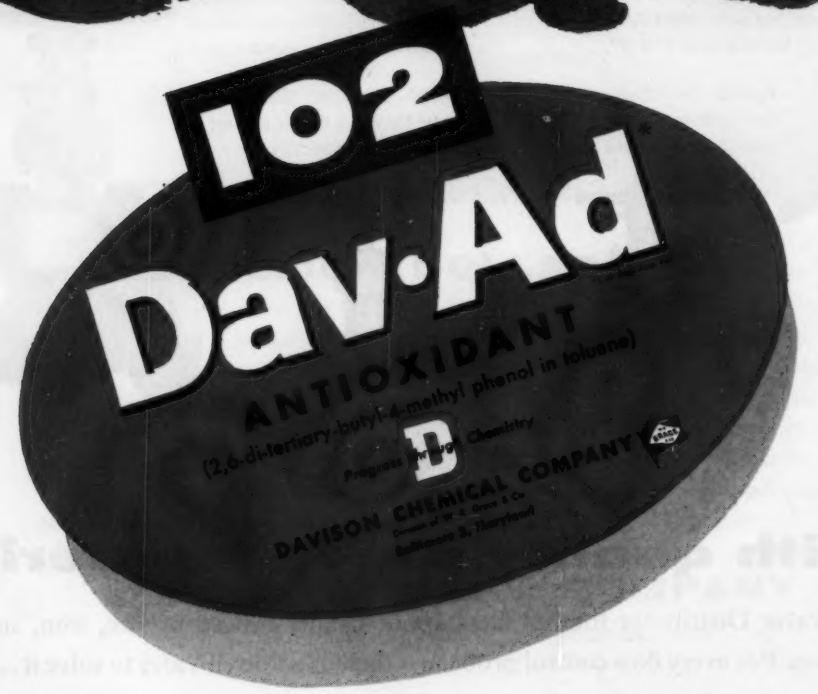
Consult your Powell Valve Distributor for full facts about quality proved bronze, iron, steel, and corrosion-resistant valves. For every flow control problem—there is a Powell Valve to solve it... *better.*

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

For more data on advertised products, use Readers' Service Cards, last page.

Announcing

DaVi



. . . Son's antioxidants

Announcing Davison's antioxidants . . . Dav-Ad 101 . . . Dav-Ad 102!

Davison, long the leading catalyst supplier, offers these antioxidants to the refining industry . . . Dav-Ad 101 and Dav-Ad 102.

These antioxidants offer more advantages than other types for use in motor gasoline and aviation gasoline, as well as turbine oils, transformer oils, lubricating oils, jet fuels, synthetic lubricants, various plastics, rubber, industrial fats and oils, asphalt tile and waxes.

Davison maintains a staff of technical personnel complete with laboratory facilities available for consultation and assistance on inhibitor or treating problems.

Write for specifications, samples and prices.

Dav-Ad 101 available in 100 pound fiber drums . . . Dav-Ad 102 available in 55 gallon steel drums containing 400 pounds net or in tank car lots. Stocks are located at Baltimore, Md., Lake Charles, La. and Cincinnati, Ohio for your convenience.

Progress Through Chemistry

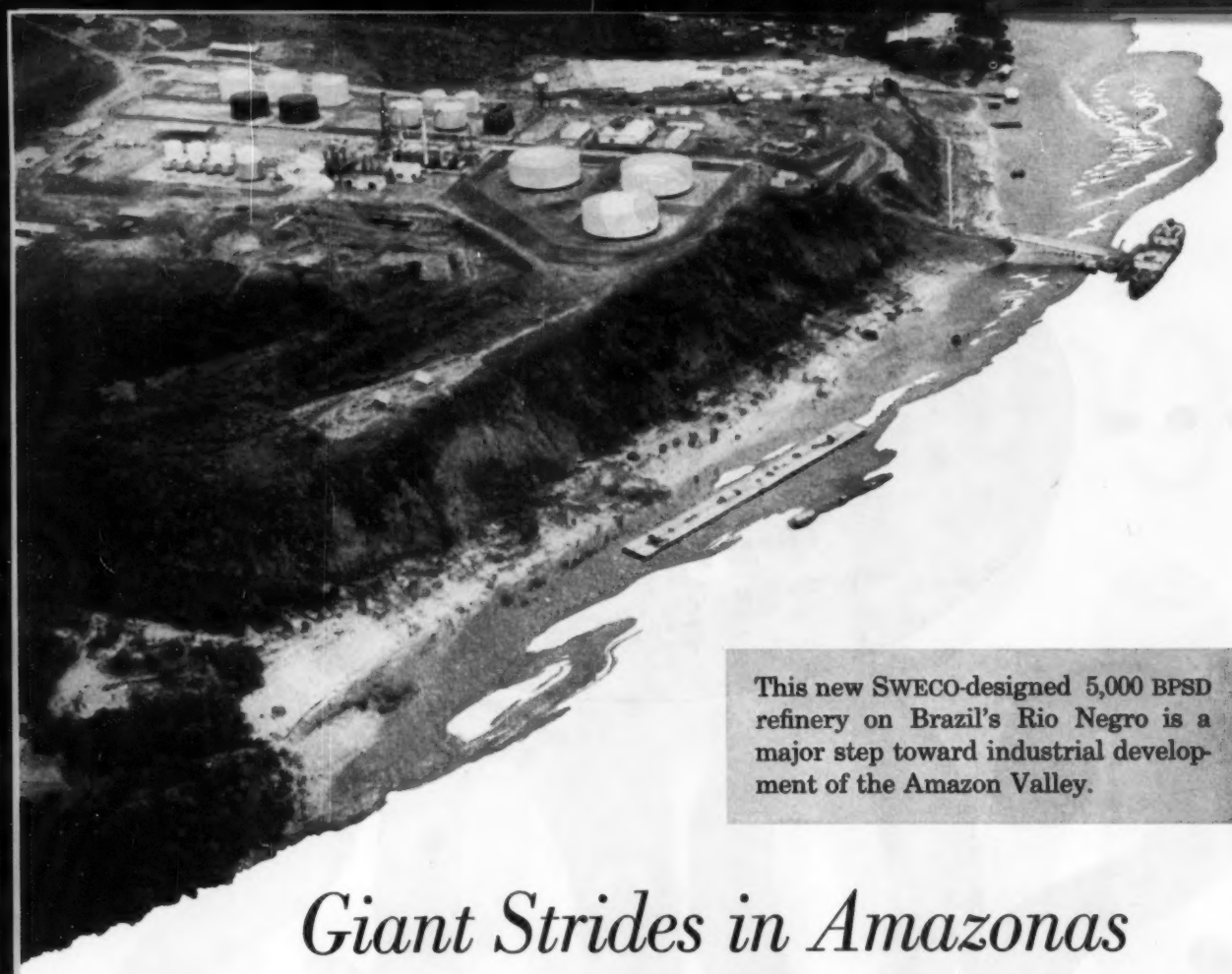
DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

SALES OFFICES: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.; San Francisco, Calif.; Tulsa, Okla.
In Canada: Davison Chemical Company Ltd., Toronto.

For more data on advertised products, use Readers' Service Cards, last page.



This new SWECO-designed 5,000 BPSD refinery on Brazil's Rio Negro is a major step toward industrial development of the Amazon Valley.

Giant Strides in Amazonas

Three weeks by ship from New York and 1,000 miles inland from Belém lies Manaus, Brazil. Here, Companhia de Petroleo da Amazonas (COPAM) wanted to build a refinery to provide an immediate source of refined oil, vital to industrial development of the Amazon Valley's vast potential.

SWECO's Engineering and Construction Division designed tanker loading and unloading facilities; storage for crude and finished products; crude and vacuum, catalytic cracking, and gas concentration units; a steam plant; an electric generating plant.

Torrents of problems

No. 1 problem was distance and communications. Manaus is 2,500 air miles from the industrial centers of southern Brazil. Contact with SWECO's home office in Los Angeles was by wireless.

Construction equipment and materials had to be shipped from the States. For five or six months each year, torrential rains slowed down operations. Labor was another big problem. It was nearly impossible to recruit trained craftsmen from the south.

Procurement and inspection

SWECO engineers were responsible for procurement as well as design. They inspected all construction – including the refinery's catalytic cracking unit, which uses a process licensed by Universal Oil Products Company, one of the many licensors providing refining processes and technology to SWECO. All heat exchangers and columns were made at SWECO's Los Angeles plant and shipped to Manaus.

To SWECO engineers who design and build moderate-size refineries, chemical plants and ore beneficiating mills all over the globe, the COPAM refinery is a clear victory over impossible logistics and elements. Whether the job is in the distant interior of Brazil or here at home, SWECO delivers . . . on schedule.

That's the basis of SWECO's reputation for dependability and service... in *engineering and construction* of refineries, chemical plants and ore beneficiating mills . . . in the design and manufacture of *process equipment* such as heat exchangers, steam jet ejectors and distillation columns . . . and in a complete line of *vibrating screen separators.*

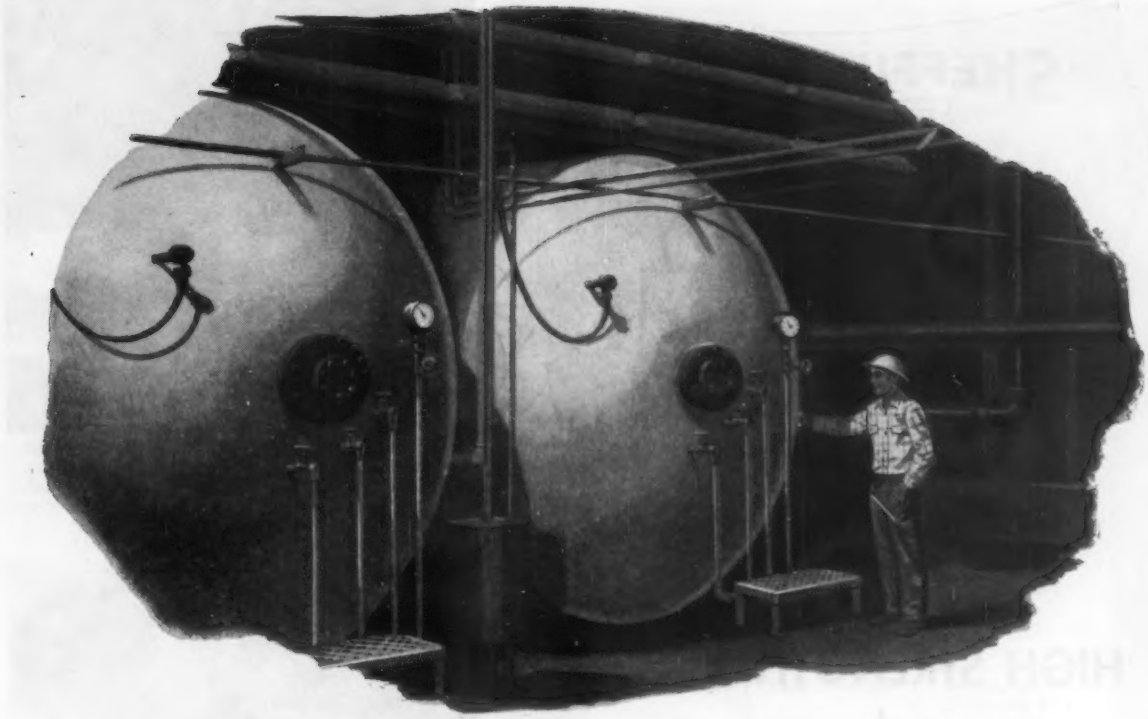
Write today for our new brochure on how SWECO products and services can help meet your processing needs. Ask for brochure E-3-333.

SWECO

Southwestern Engineering Company

Engineers and Constructors . . . Manufacturers

4800 Santa Fe Avenue • Los Angeles 58, California



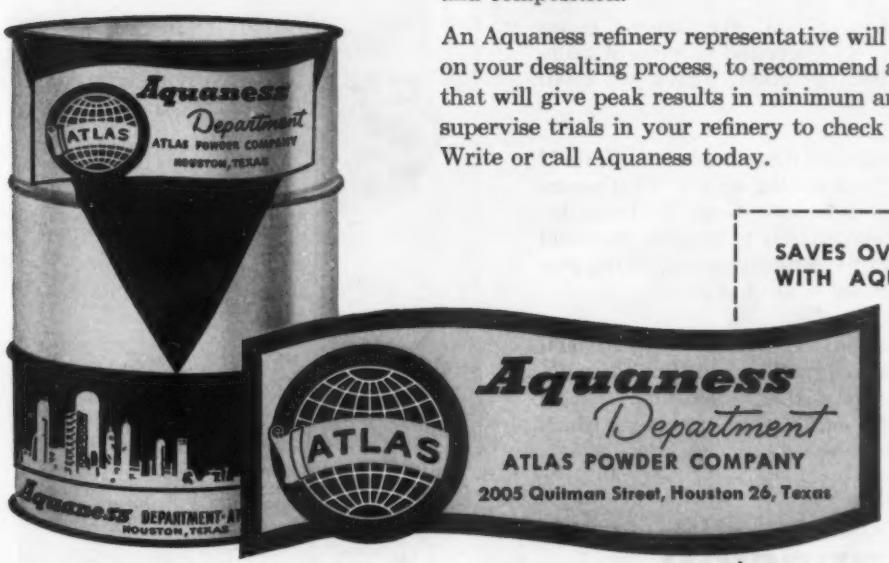
cut chemical costs in half

with Aquaness desalting compounds

You'll save money, because Aquaness materials are concentrated. They're more economical to use, to ship, to store.

You'll eliminate trouble, because Aquaness materials work with a wide range of crudes. You don't need to switch chemicals or adjust feed rate when incoming crude varies in gravity and composition.

An Aquaness refinery representative will be glad to consult on your desalting process, to recommend an Aquaness compound that will give peak results in minimum amounts, and to supervise trials in your refinery to check performance. Write or call Aquaness today.



SAVES OVER $10,000 PER YEAR WITH AQUANESS COMPOUNDS

A leading refinery processing 8 different crudes at a total charge of 30,000 bbl/day has cut its desalting chemical cost by 52% by changing to concentrated Aquaness compound. Chemical savings amount to more than $10,000 per year.

Chemicals for Refining, Gasoline Plants and Oil Transportation

For more data on advertised products, use Readers' Service Cards, last page.

SHEFFIELD

ARMCO

ALLOY STEEL made to fit the needs of the WEST

by the West's only producer

HIGH STRENGTH and AIRCRAFT QUALITY GRADES

available in

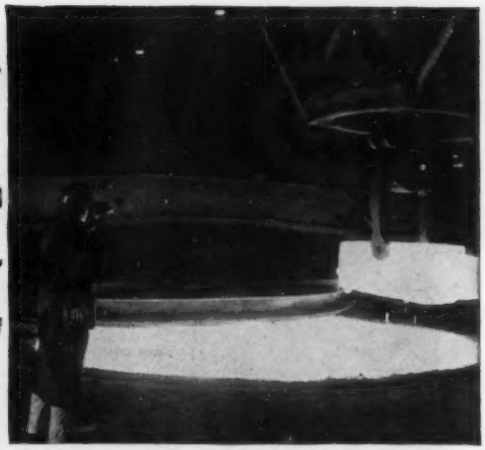
STRIPS • PLATES • ROUNDS • SQUARES • FLATS
ROUND-CORNERED BARS AND BILLETS • BLOOMS

Marvels of modern metallurgy, Sheffield Alloy Steels provide strength-to-weight ratios that (in the higher tensile-strength brackets) make steel actually lighter for the load it carries than any other commonly used metal.

A fact literally worth its weight in gold! For example, excess weight in aircraft costs around $500 a pound in terms of maintaining strength and economical operation. That's just about the going price of gold.

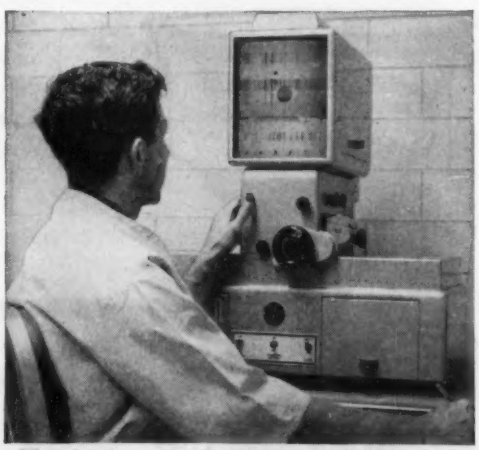
Not only in aircraft, but in countless other steel uses, Sheffield Alloy Steels add strength without adding weight. That means better products and better values for everybody. To bring this about, alloy steels must be made precisely to formula. Sheffield makes it a sure thing — with the most advanced testing procedures at every step from furnace to finished steel.

If you're a manufacturer of any product using alloy steels, you'll find the metal tailored to your needs in Sheffield High-Strength, Shef-Ten, Forging and Aircraft grades. Sheffield's strategic locations make possible service and buying advantages which will interest you. Get in touch with us.



Constant control of temperatures to precise specifications is a vital part of making alloy steels. The metallurgist above is making a quality control check of an ingot, using a sensitive optical pyrometer.

Micro-examination of steel samples is one of many checks Sheffield uses to guard the quality of Sheffield Alloy Steels.



The densitometer gives spectographic analysis of steel samples—measuring the density of the spectrum lines to determine the amount of each chemical element present.

SHEFFIELD DIVISION ARMCO STEEL CORPORATION

SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA — OFFICES IN PRINCIPAL CITIES

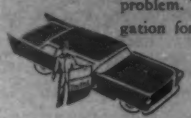
For more data on advertised products, use Readers' Service Cards, last page.

if you refine oil... and answer
FIND YOUR REFINERY PROBLEM HERE

There are Tretolite Company products and services to help your refinery operate more smoothly, stay on stream longer, reduce operating costs and market better products. Here are a few of the problems they are helping to solve in other refineries every day:

PROBLEM	TRETOLITE PRODUCT	APPLICATION
Salty Crude	Tretolite Desalting	Crude Charge
Corrosion	Kontol Corrosion Inhibitors	Internal Piping, Refinery Equipment
Tank Bottoms	Tretolite Demulsifiers	Storage Tank Settlings
Waste Oil	Tretolite Water De-Oilers	Waste Oil Separators
Product Emulsions	Tretolite Fuel Emulsion Preventives	Burning Oils and Diesel Fuels
Copper Contamination	Kuplex Metal Deactivator	Gasoline, Kerosene, Jet Fuel, Diesel Oil, Burning Oil

The Tretolite Company Refinery Service Department is always available to assist you in any refinery problem. There is no charge or obligation for consultation or advisory service. Just ask your Tretolite Refinery Service Engineer...



THE MAN IN THE RED CAR

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri

5515 Telegraph Road, Los Angeles 22, California

Chemicals and Services for the Petroleum Industry

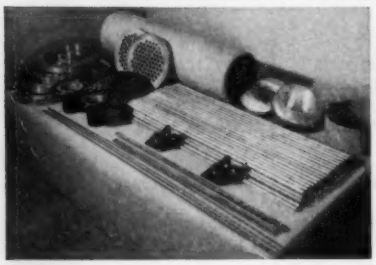
DESALTING • DEMULSIFYING • CORROSION INHIBITING • SCALE PREVENTING • FUEL OIL ADDITIVES • WATER DE-OILING • METAL DEACTIVATORS

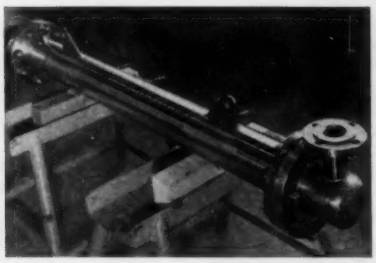
AR-57-2

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.





From stock parts... to finished heat exchanger... to you without the time consuming delay of "custom design."

Pfaudler stockpiles a complete line of flexible-standard components which can be assembled to fill your needs in *two to six weeks.*

Two-week delivery possible

If your process requirements can be met by either a single- or double-pass carbon shell heat exchanger in the capacity range between 56 to 316 sq. ft., you can get "off-the-shelf" delivery in *just two weeks.* Other standard sizes up to 20" shell diameter are quickly assembled to your specifications in just *four to six weeks.*

Tally these added advantages to your profit when you order Pfaudler heat exchangers:

They're versatile. Use them as heaters, condensers, or coolers. These units are designed to ASME and TEMA codes for 75 psi tube pressure and 150 psi shell side pressure up to 350° F. Only slight modifications are required for higher pressures and an expansion diaphragm can be added to meet higher temperature gradients.

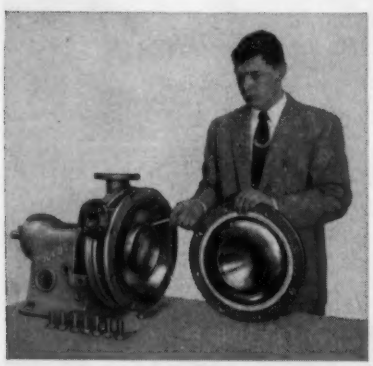
They're economical. Due to standardization of design and the pre-stocking of components, they cost much less than custom built units.

They're leakproof. No internal gasket. No possible intermixing of the hot and cold fluids because of gasket failure.

The flexible standard components are all made of stainless steel. However, when your requirements call for them, these parts can be made of Nickel, Inconel, Monel, Hastelloy, Zirconium, Titanium, and combination glassed steel with Karbate or alloys.

Pfaudler engineers are always ready to help you with your heat exchanger problems.

You'll also find a copy of Manual 837, "Pfaudler Heat Exchangers and Condensers," helpful. Along with complete descriptions of Pfaudler heat exchangers and condensers, it contains useful performance and thermal design data. Write for a copy today.



New glassed pump fights off corrosion for years. A new Goulds' centrifugal pump with Pfaudler glassed interior surfaces assures *years* of corrosion-free operation at low cost.

Resists *all* common acids except hydrofluoric to at least 212°F. and alkaline solutions up to pH 12 at 212°F.

Write to Goulds Pumps Inc., Seneca Falls, N. Y. for descriptive bulletin.

How to take the guesswork out of buying columns

It's no easy matter to select the proper columns for a given operation.

You have to balance such diverse factors as cost, corrosion resistance, handling and cleaning, vapor and liquid capacity, pressure drop, load efficiency, etc., etc., etc.

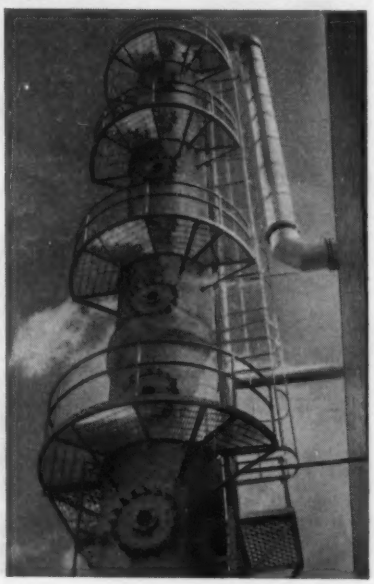
Pfaudler has had long years of experience designing and fabricating columns for fractionating, stripping, absorption, extraction, and numerous other chemical reactions.

You can make good use of our experience in fabricating with glassed steel, as well as a great many alloys, and from our design experience with bubble caps and perforated or sieve tray columns, Turbogrid tray column, as well as packed and spray type columns.

To begin with you can find the answers to many basic questions in our Bulletin No. 940. Write for a copy.

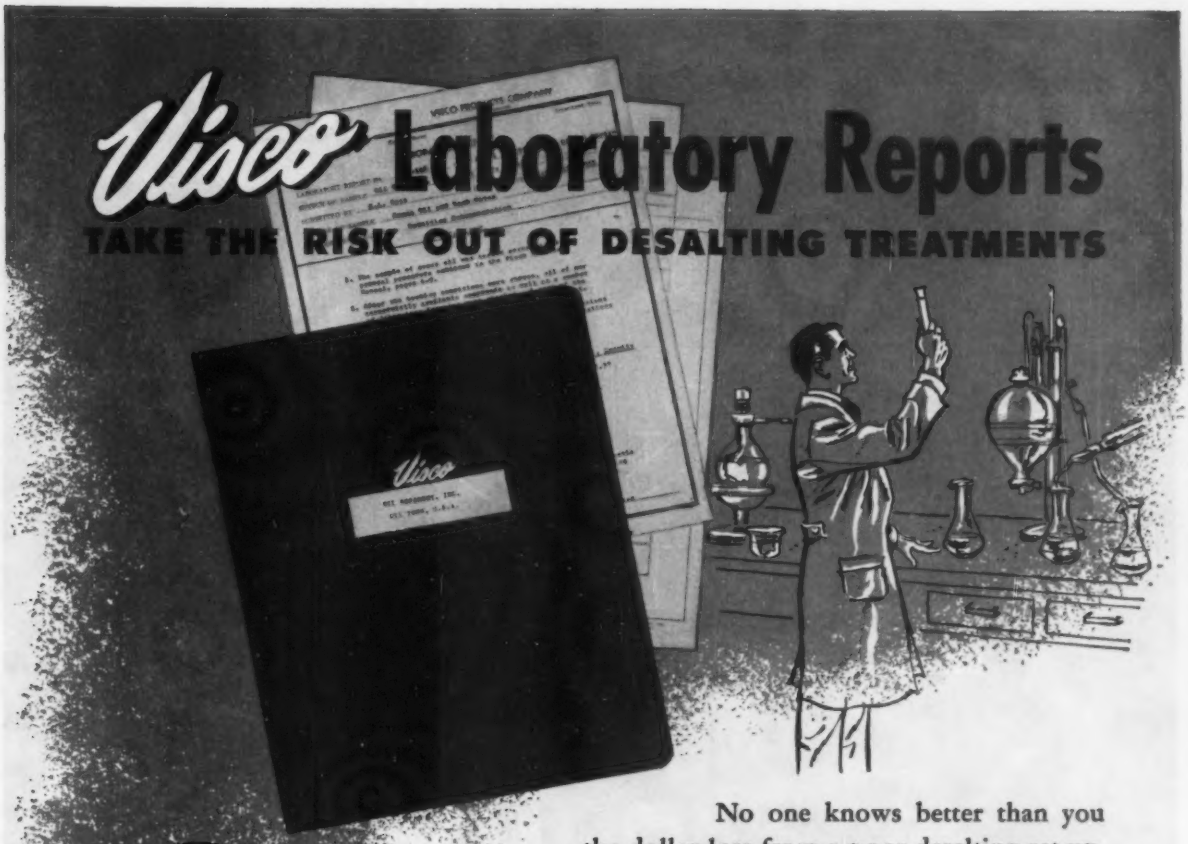
Then you can check with Pfaudler for detailed answers to your specific problems.

Result? Simply the right column for your process.



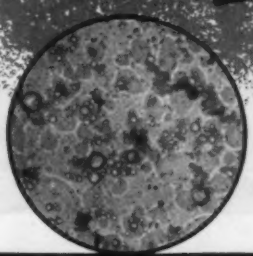
Visco Laboratory Reports

TAKE THE RISK OUT OF DESALTING TREATMENTS



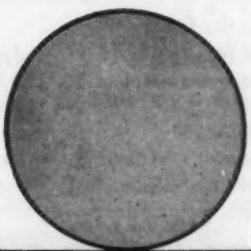
No one knows better than you the dollar loss from a poor desalting set-up.

And you know, too, there's no such thing as a blanket cure-all. But a Visco Laboratory Report *does* point the way to the results you want—from every type of crude—at no added cost to you.



Photomicrograph—
Emulsified refinery crude

In a typical case, 20 or more separate desalting compounds and laboratory formulas may be checked and all contributing factors will be considered before the final desalting recommendation is made.



Photomicrograph—Emulsified refinery crude after Visco desalting

If you would like our desalting recommendation for your crude, send Visco a five-gallon can of the crude and one gallon of the water used in your refinery desalting. Or better yet, check with your Visco representative, and he will arrange for these services.

VISCO PRODUCTS COMPANY
INCORPORATED
2600 Nottingham at Kirby • Houston 5, Texas • Telephone: MAdison 3-0433

Visco® CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS

For more data on advertised products, use Readers' Service Cards, last page.

ACCO
for Better
Values

R-P&C VALVES

DESIGNED FOR DEPENDABILITY

BAR STOCK VALVES FOR CLOSE CONTROL, ESPECIALLY SUITED FOR CLOSE-COUPLED INSTALLATIONS

• rated for pressures up to 10,000 PSI •

• The bar stock valve, designed originally by R-P&C engineers, is really a versatile performer. First developed for instrument use, bar stock valves have proven to be the answer to valve problems of many different kinds. Designed for close control, they are ideal for throttling service. Their compactness makes them the natural choice for crowded locations such as panel boards. Economically priced, they serve in many applications as general purpose valves. And they are built in a wide variety of materials—can withstand extremely high temperatures and pressures.

For example, the **Fig. 1040-A Valve** shown here, made from carbon steel, is rated for 10,000 psi at 150°F. Each of these valves is individually tested at 15,000 psi before it leaves the factory.

R-P&C's complete line of bar stock valves includes constructions in 12-14 chromium stainless steel, 18-8 molybdenum stainless steel and bronze. Sizes range from ⅛" to 1" in globe and angle styles with female ends, male and female ends, or male union ends. For extremely severe throttling services, R-P&C bar stocks can be supplied with stellite discs for extra abrasion resistance.

Your R-P&C distributor carries not only a complete line of bar stock valves but also a wide selection of gate, globe, angle and check valves in bronze, iron, and cast and forged steel. You will find the answer to your valve problem in his selection.

FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

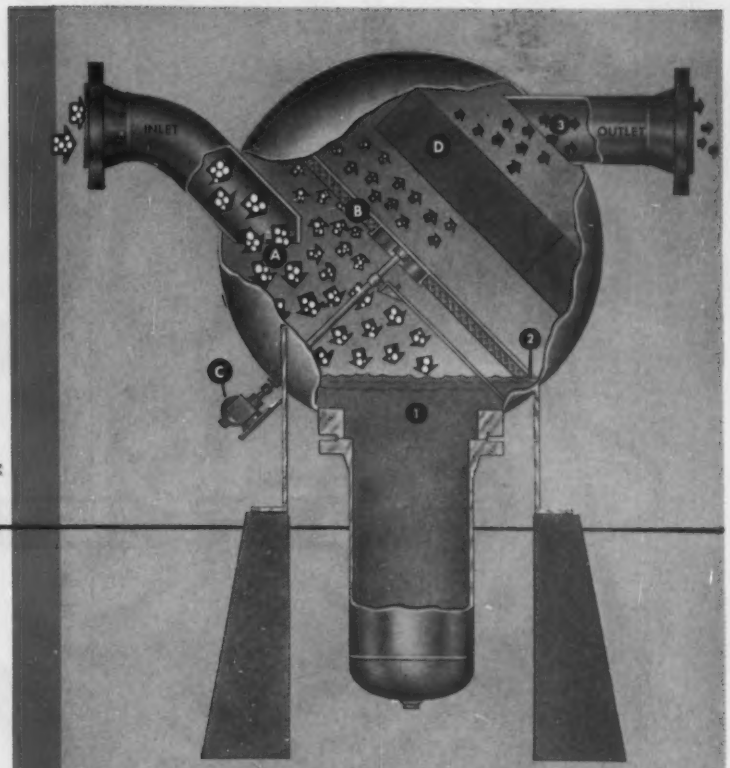
Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

MORE EFFICIENT RESULTS!

PEERLESS SCRUBOSPHERE*

*Spherical scrubber for dust and liquid removal from gas flow

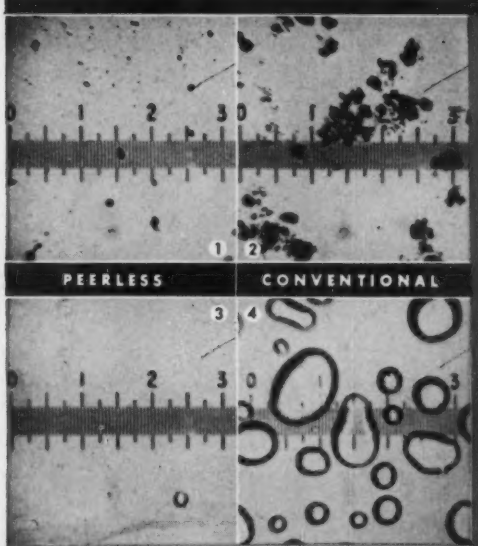


(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving through liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3



These photographs were made of microscope slides introduced downstream of the Scrubosphere and a conventional vertical oil bath cleaner under the same operating conditions. Plates 1 and 2 show the comparative amounts of iron oxide not removed with the amounts introduced being identical. Plates 3 and 4 indicate comparative oil loss with vapor rate through the vessels being the same.

LOOK AT THIS TEST The test at the left indicates the superiority of Peerless Scrubosphere over conventional oil bath dust scrubbers. The SCRUBOSPHERE operates with no loss of efficiency at low flows, minimum liquid loss, and very low pressure drop. Other outstanding features include easy vessel access with removable self-cleaning contactor, a sump for slugs of solid or liquid particles, and minimum cost.

For detailed information write for Bulletin No. 181

PEERLESS MANUFACTURING CO.

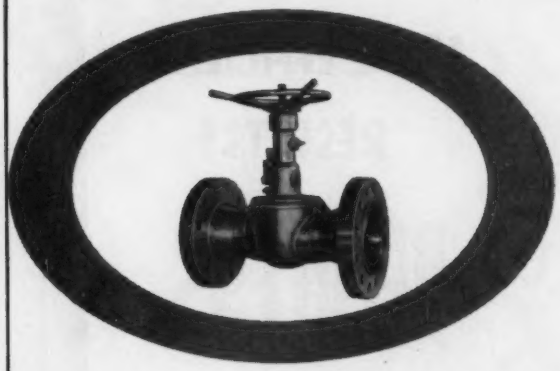
P.O. Box 13165 Dallas, Texas

Representatives in All Principal Cities

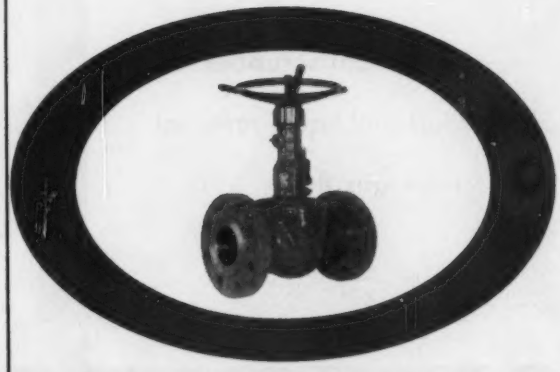
PEERLESS MFG. CO. DALLAS TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

Venturi Type — available sizes: Flanged End only, ASA Class, 2, 2½, 3, 4 & 6 inches, beginning with 150 lbs., thru 2500 lbs., Carbon & Stainless Trim.



ORBIT



LONG-RANGE SAVINGS WITH LONG-LASTING ORBIT VALVES

Full Round Opening sizes available in Flanged & Screw End ASA Class, 1, 1½, 2, 2½, 3 & 4 inches, beginning with 300 lbs., thru 2500 lbs., Carbon & Stainless Trim.

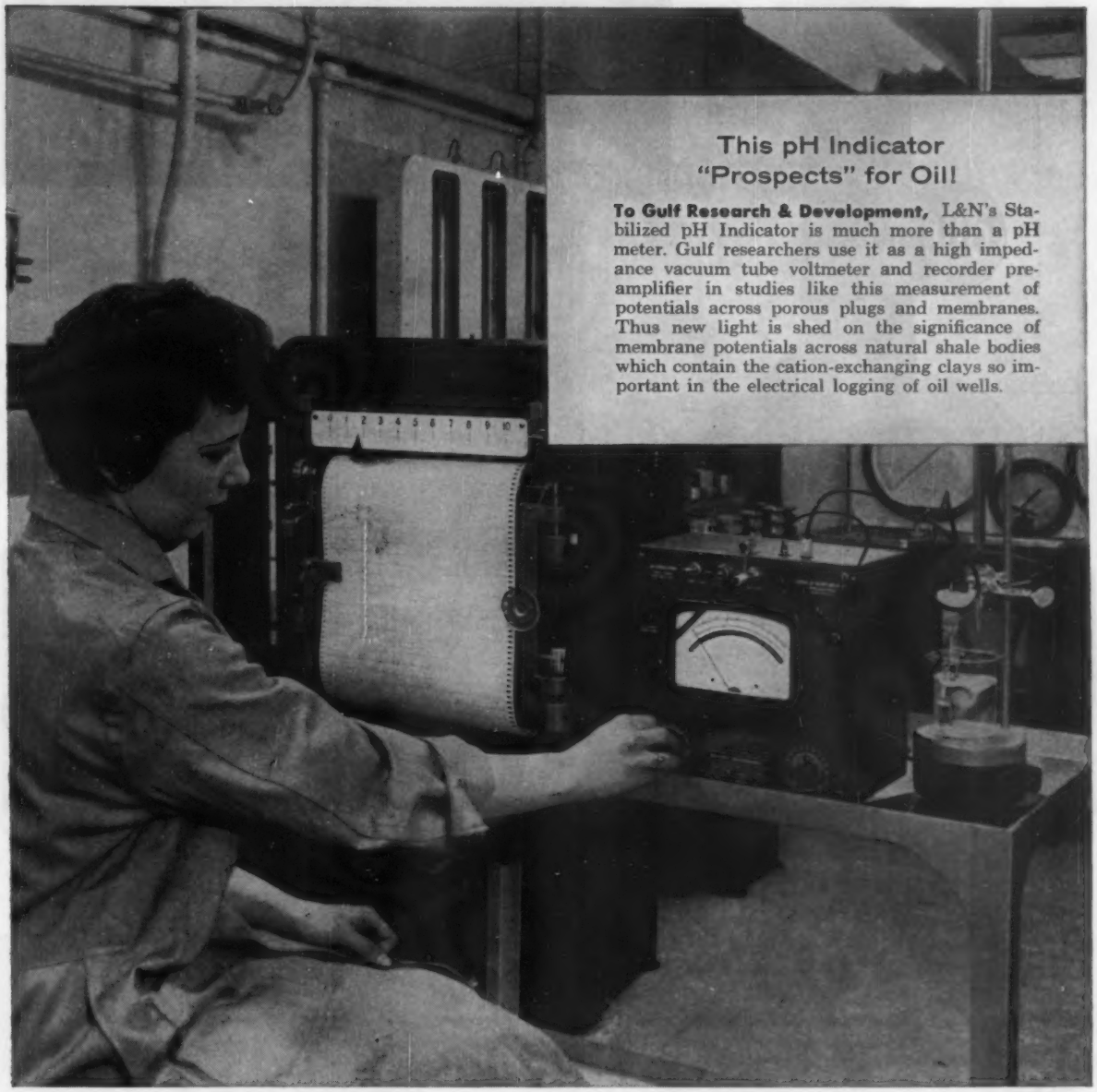
Plant maintenance men know that Orbit Forged Steel ASA Class Valves have established an outstanding record for trouble-free service. And that is why these key operating men ask for ORBIT VALVES for new plant construction, replacement and expansion programs. Maintenance is extremely low on Orbit valves—they are built to give long years of trouble-free service —and this adds up to long-range savings.

ORBIT VALVES®

WAREHOUSES: **Houston, Texas,** 407 Velasco, CApitol 8-6623, TWX HO 115; **Odessa, Texas,** 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8041; **Casper, Wyoming,** 247 West First St., Phone 3-5707, TWX CP 394; **Long Beach, California,** 1425 West 15th Street, HEmlock 7-6206; **Edmonton, Alberta, Canada,** 7119-104th Street, Phone 391-283
CANADIAN REPRESENTATIVE: T. R. Pickford & Company, Ltd., Calgary, Alberta, 536 8th Avenue West, Phone 2-7371
EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Ave., BRyant 9-2236

ORBIT VALVE COMPANY

P. O. BOX 699 • TULSA, OKLAHOMA



This pH Indicator "Prospects" for Oil!

To Gulf Research & Development, L&N's Stabilized pH Indicator is much more than a pH meter. Gulf researchers use it as a high impedance vacuum tube voltmeter and recorder preamplifier in studies like this measurement of potentials across porous plugs and membranes. Thus new light is shed on the significance of membrane potentials across natural shale bodies which contain the cation-exchanging clays so important in the electrical logging of oil wells.

Here's why leaders in American Industry are using the L&N Stabilized Indicator

Quick Warm-Up—less than 60 seconds.

Fast Response—about 1.5 seconds.

Measuring Errors "Designed Out"—completely unaffected by zero drift, electrical pickup, a-c surges.

Only Two Adjustments—standardization and temperature compensation.

Fine Performance—limit of error, ±0.1 pH; reproducibility, ±0.02 pH.

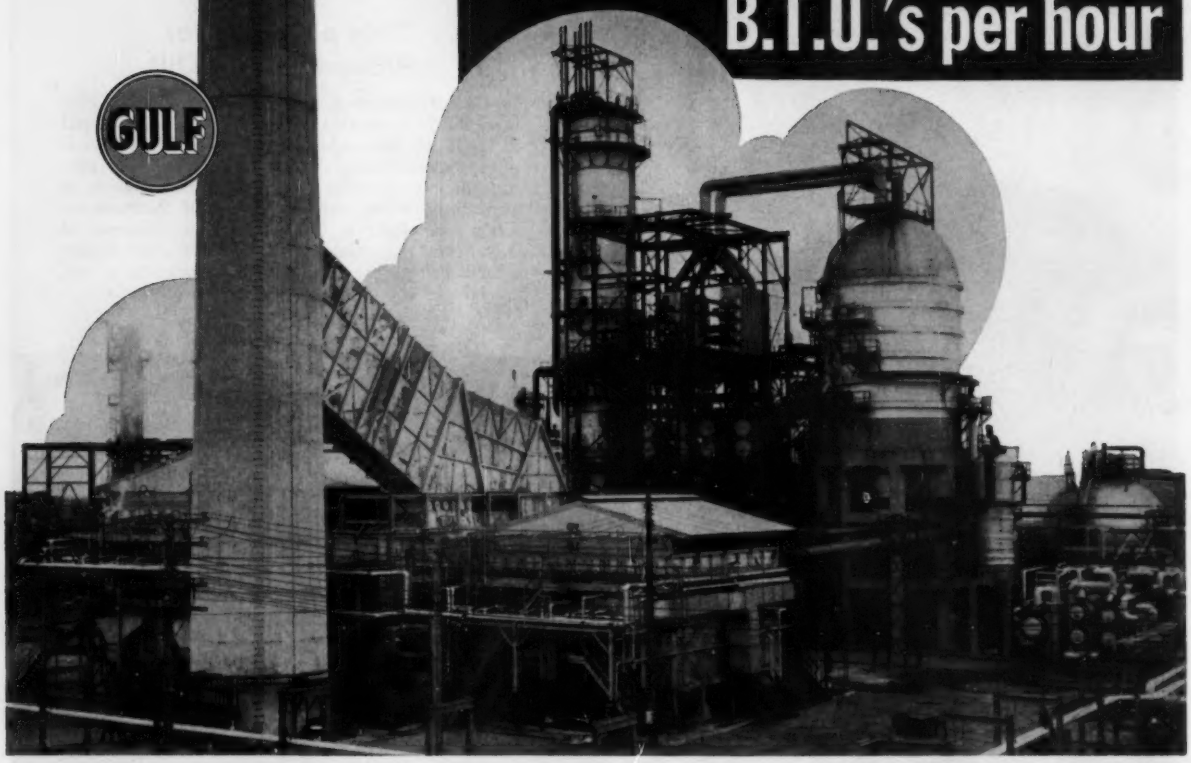
Low Price—$275.75 for 120 v. model, $300.75 for 240 v. model, f.o.b. Phila. (subject to change without notice). Supplied with glass and reference electrodes, buffer, and potassium chloride solution.

Use No. 7664-A1 (120 v.) or 7666-A1 (240 v.) when ordering, or write Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, for details in Data Sheet E-96(2).

LEEDS & NORTHRUP
instruments *automatic controls* • *furnaces*

For more data on advertised products, use Readers' Service Cards, last page.

600,000,000 B.T.U.'s per hour



Forty-eight NATIONAL AIROIL Tandem Units fire Gulf's huge Crude Heater at Philadelphia.

with NATIONAL AIROIL'S *Exclusive* TANDEM COMBUSTION UNITS

This tremendous Combination Atmospheric—Vacuum Crude Heater at Gulf Oil Corporation's Philadelphia Refinery, was constructed by Foster Wheeler Corporation . . . for a total burner liberation of up to 600,000,000 B.T.U.'s per hour.

NATIONAL AIROIL *exclusive* Tandem Combustion Units achieve this capacity with maximum economy and availability.

These NATIONAL AIROIL oil burners are *all-alloy* for burning high temperature pitch separately, or in conjunction with non-aerated gas burners. Additional burners are also provided for waste gas disposal.

NATIONAL AIROIL Tandem Units are recognized as standard firing equipment in oil refinery and chemical plant heaters throughout the world. They are noted for versatility regarding fuels; and insure correct flame placement so necessary to avoid damage to the heat-absorbing tubes.

Your furnace maintenance problems are measurably reduced, and hours on stream greatly increased by use of Tandem Combustion Units.

Further information sent upon request on your letterhead.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

NATIONAL AIROIL BURNER

Main Office & Factory: **1254 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

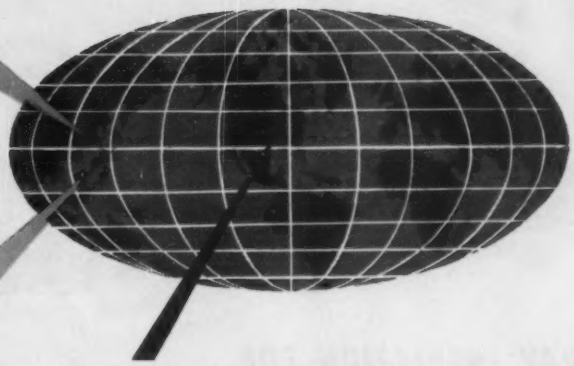
UREA

...the commercially proven CHEMICO PROCESS

A view of the 90 tons per day Urea Plant at Niigata designed by Chemico for Nippon Gas Chemical Industries Ltd.

A part of the 120 tons per day Urea Plant designed by Chemico for Sumitomo Chemical Company Ltd. at Niihama.

NOW...200 T/D
under contract in North America



The success of the Chemico synthetic urea process is reflected in the company's record in Japan. The 40 tons per day plant built for Sumitomo Chemical Company at Niihama in 1952 has been expanded twice to 120 tons per day operation. On the basis of this record, Chemico was awarded a contract by Nippon Gas Chemical Industries for a 90 tons per day plant at Niigata. This plant started on stream in the spring of this year. Now . . . Chemico has been awarded the contract for a 200 tons per day Urea Plant in North America, utilizing the Chemico process. Production experience at the Sumitomo plant has shown the following advantages of the Chemico urea process:

- High conversion of the carbamate to urea per pass.
- Simple recovery of the excess ammonia in liquid form without additional compression.
- Efficient recovery of the ammonia from the unconverted ammonium carbamate for full recycle to obtain overall high ammonia yield.
- Produces spherical free-flowing granules which require no coating agents.
- The Chemico process can be used for the production of urea in fertilizer and industrial grades.

For more detailed information on the commercially proven Chemico process, write, wire or call . . .

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY

525 West 43rd Street, New York 36, N. Y. • Cable Address: CHEMICONST, New York
Affiliated Company: CHEMICAL CONSTRUCTION (GREAT BRITAIN) LTD., LONDON, ENGLAND
REPRESENTATIVES in JOHANNESBURG • PARIS • TOKYO

For more data on advertised products, use Readers' Service Cards, last page.

76 years of KOVEN fabricating *Experience* built into every job

High Pressure Autoclave 105 Feet Long, with Quick Opening Doors. Weight: 40,000 Pounds.

X-RAY INSPECTION FOR QUALITY CONTROL

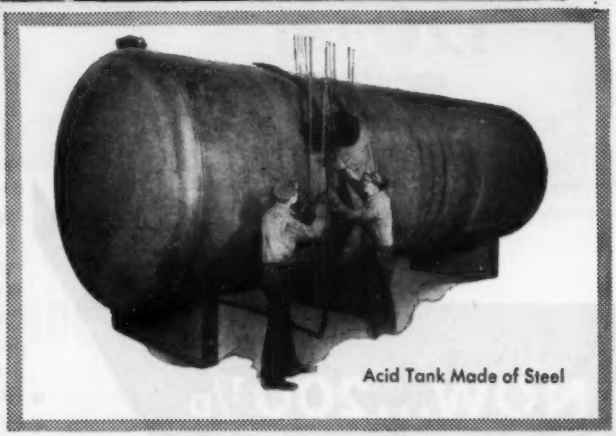
KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks stacks; breechings; hot transfer lines; large diameter fabricated piping and plate exhaust ducts; shop and field erected storage tanks; high vacuum testing.

SPECIALISTS IN INTRICATE FABRICATION USING:

• STAINLESS STEEL • ALUMINUM • MONEL • NICKEL
• INCONEL • ALL CLAD MATERIALS • NICKEL PLATED STEEL

Fabrication to all A.S.M.E. Codes

See Sweet's Catalog File and Chemical Engineering File



Acid Tank Made of Steel

A. S. M. E. Welded Chemical Fractioning tower 105 Feet Long

Altitude Testing Chamber—Built For Testing Instruments or Simulated Altitudes for 80,000 Ft.

Call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550

Members of Steel Plate Fabricators Association

Koven

FABRICATORS, INC. 91 E. Dickerson St., Dover, New Jersey

Telephone: FOxcroft 6-0400 *PLANTS:* JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.

when the chips are down...

U. S. Nuclear Submarine photo courtesy of Electric Boat Div., General Dynamics Corp. Groton, Conn.

only the best is good enough!

When Electric Boat Division was selected to construct America's Atomic Submarine Fleet, Metallo Gasket Company headed their list of outstanding suppliers because Metallo Gaskets have proven their superior sealing efficiency, longer life and ability to retain physical and chemical properties under the most fatiguing service requirements.

Wherever the best in gaskets is required, Metallo Gaskets are specified. Metallo Gaskets are built for specific requirements in strict accordance with customer's specifications or templates in any workable metal. Yet, Metallo Gasket prices are low. Contact Metallo today for complete information and price schedules.

Metallo Engineers will be glad to discuss the factors involved in sealing any type of equipment. Your request for consultation and estimates will not obligate you in any way.

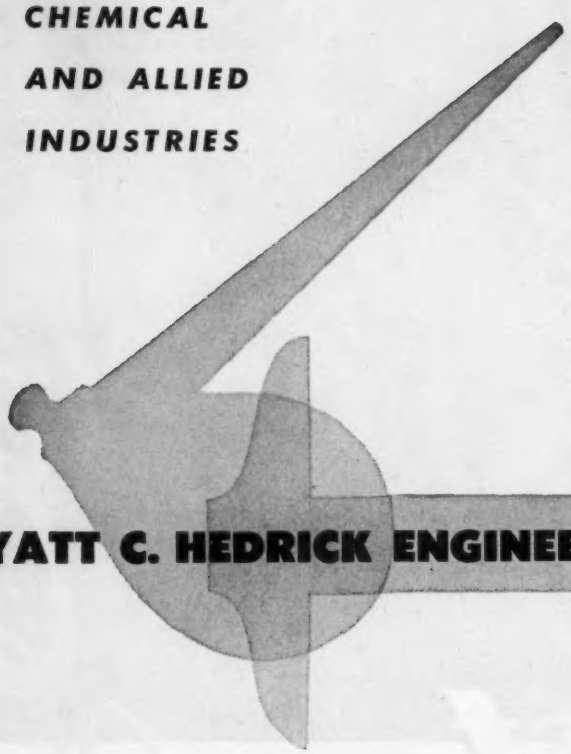
Send for new 20 page gasket catalog

metallo gasket co.

13 Bethany St. • New Brunswick, New Jersey

Standard & Custom Gaskets • Special Gaskets for Heat Exchangers & Air Conditioning Apparatus
Valve Discs • Raschig and Lessig Rings • Metal Stampings

SERVING THE
PETROLEUM
NATURAL GAS
CHEMICAL
AND ALLIED
INDUSTRIES



WYATT C. HEDRICK ENGINEERING CORPORATION

HOUSTON, TEXAS

CONSULTATION, PROCESS AND DEVELOPMENT ENGINEERING, SURVEYS AND ECONOMIC STUDIES ARE A PART OF OUR BROAD ENGINEERING SCOPE.

DETERMINATION OF THE REQUIREMENTS FOR RAW MATERIALS, UTILITIES AND PLANT INVESTMENT PLUS AN EXTENDED FORECAST OF EARNINGS WHICH PROPERLY RELATES THESE ITEMS IS NECESSARY FOR A REALISTIC RE-EVALUATION OF YOUR INTEREST IN ANY PROCESS.

What do you want in
WELDING
FITTINGS?
For any welded piping job you want fittings that fit — no disgusting last-minute complications.
You want fittings made of materials that measure up to your specifications — no mysterious failures.
You want a source for special as well as regular fittings. You want to avoid unnecessary welds, makeshift expedients, clumsy combinations.
You want to avoid procurement ordeals — the business of trying to make yourself understood. You want to do business with alert men who speak your language — engineers if you need them.
And — you want to know your business is appreciated.
The best answer to your welding-fittings wants, of course, is in your nearby J&L Supply store.
Jones & Laughlin
SUPPLY DIVISION – Tulsa
SERVING THE UNITED STATES AND CANADA
27-G

For more data on advertised products, use Readers' Service Cards, last page.

J-M BLAZECRETE speeds refractory repairs...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place.

When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete goes on fast . . . without laborious ramming or tamping. *And Blazecrete linings last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix . . . can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

The Mail Box . . .

Table Omitted

To The Editor:

Your workup of our naphthene-paraffin paper in the March issue is excellent. We are well pleased.

One slight problem: Somehow, by my error, Table 15 was missing from the original manuscript and I didn't catch the omission when I checked the proofs. Unfortunately, Figure 8, which plots the data from Table 15, has an error in the title. The title should read, "Activity Coefficients at 40 degrees C," not at 769 mm Hg.

I'm sending you a copy of Table 15. You may want to print it as a correction.

Henry Myers
C F Braun & Co.
Alhambra, Calif.

TABLE 15

Vapor-Liquid Equilibrium Data for the System

Pentane-Cyclohexane
Temperature — 40 C

Mol Percent Pentane		Absolute Pressure MM HG	Relative Volatility Alpha
Vapor	Liquid		
0.0	0.0	188.0	....
20.8	4.3	193.0	5.85
28.15	6.75	241.5	5.40
35.2	9.7	264.0	5.06
40.75	12.1	283.0	5.00
46.6	14.1	299.0	5.32
50.5	16.6	322.0	5.12
56.55	20.1	350.0	5.17
60.8	26.15	384.0	4.37
63.65	27.5	388.0	4.62
64.8	28.1	395.0	4.45
65.1	29.75	406.0	4.41
71.3	34.8	443.0	4.64
71.5	35.7	445.0	4.52
74.65	40.0	483.0	4.43
75.3	40.1	479.0	4.55
76.8	41.8	491.0	4.60
77.0	42.6	499.5	4.51
81.0	49.7	552.0	4.31
81.7	50.0	548.0	4.46
82.25	50.5	548.0	4.54
85.8	59.0	599.0	4.20
87.0	60.2	612.0	4.42
89.0	63.8	634.0	4.59
89.0	66.7	651.0	4.04
90.65	68.8	666.0	4.40
90.5	69.55	674.0	4.17
91.4	72.2	690.0	4.08
93.3	77.3	718.0	4.09
93.3	78.5	730.0	3.81
94.2	79.4	735.0	4.20
96.8	90.0	799.0	3.35
98.2	94.2	832.0	3.37
100.0	100.0	865.0	....

Blames Car Design

To The Editor:

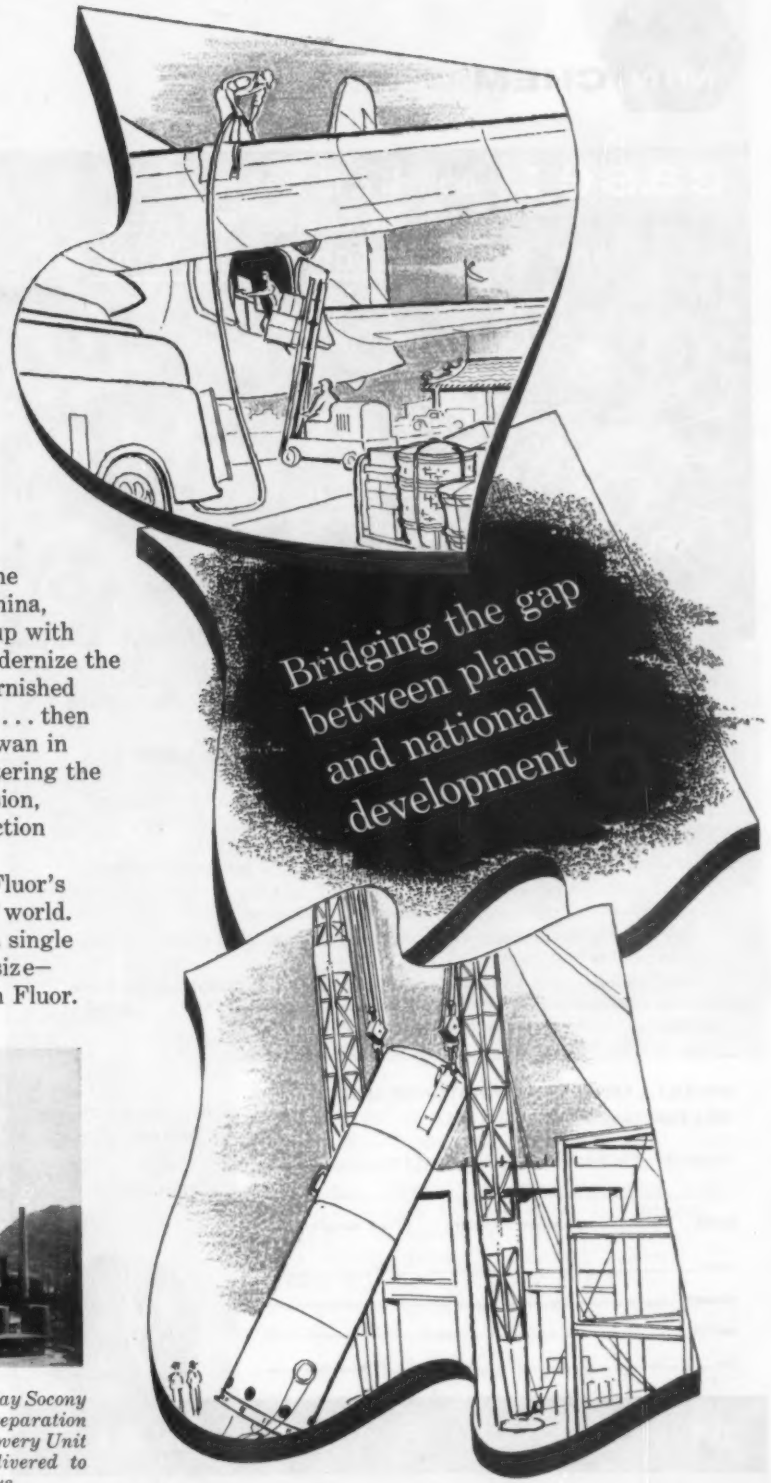
The LOOK BOX in your March issue discusses the mounting toll of lives and injuries in automobile accidents . . . and what the oil industry can do to meet this challenge . . .

In seeping the solution of these problems, it doesn't make sense to be concerned completely and solely with schoolmastering operators, installing new lights, laying out new roads, designating one way streets and calling on operators to drive their cars by a multitude of signs. That amounts to absolving the machine itself—the one common factor in all this.

Today's passenger automobile is so designed and built that it causes accidents. These modern blunderbuses average to

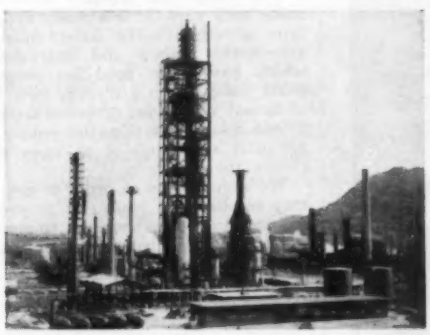
For more data on advertised products, use Readers' Service Cards, last page.

FIRST HIGH OCTANE UNIT FOR FREE CHINA



To provide high octane gasoline for the increasing industrial needs of Free China, The Fluor Corporation, Ltd. teamed up with Chinese Petroleum Corporation to modernize the Kaohsiung Taiwan refinery. Fluor furnished design, engineering and procurement... then trained a group of key men from Taiwan in advanced construction methods. Mastering the unit lift method under Fluor supervision, Chinese personnel completed construction operations in record time.

This unique project demonstrates Fluor's extreme flexibility in any part of the world. Whatever your requirements—from a single service to a complete project of any size—it will pay you to get acquainted with Fluor.



THE TCC UNIT (10,000 barrel-per-day Socony Mobil process) plus a new Feed Preparation Unit and Fractionation and Gas Recovery Unit were engineered, procured and delivered to U. S. ports by Fluor in only 205 days.

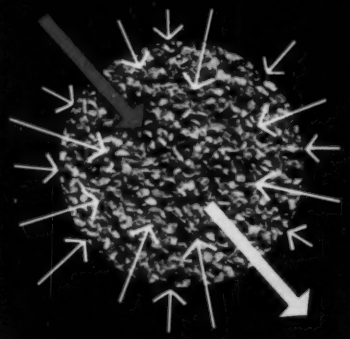
FLUOR *ENGINEERS and CONSTRUCTORS for the Petroleum, Chemical & Power Industries*

The FLUOR CORPORATION, Ltd., Los Angeles – Mid-Continent Division, Houston – Research Division, Whittier, California – Fluor of Canada, Ltd., Toronto – Singmaster & Breyer, Inc., New York City

For more data on advertised products, use Readers' Service Cards, last page.

MIN CHEMISTRY *at work*

case: how M & C materials and methods get the job done by sorption processing



Ad- or *ab-* . . . whichever prefix to sorption you prefer . . . M & C works with you to get the right balance of medium, efficiency, purity, treating conditions and economy.

Sorptive Mineral Report: M & C offers many grades for many jobs.

Molecules Out—you can refine, purify, decolorize; remove odors, colors, taste, moisture, acids, sulfur compounds, fluorides, unsaturates, many others.

Molecules In—other grades serve as carriers in scores of processes.

Anti-Caking—often 1% or less of specific sorptive grades make sticky, waxy, hygroscopic chemicals free flowing.

Drying—M & C desiccants dry air, hydrogen, CO_2, hydrocarbons, other fluids and gases.

Our business is to supply low-cost, nature-given materials that are *process-engineered* to make things go smooth in your plant . . . good in your markets. Use the coupon.

MINERALS & CHEMICALS CORPORATION OF AMERICA
3014 Essex Turnpike, Menlo Park, N.J.

I'm interested in a natural mineral product for_____

Send: ☐ Detailed adsorbent literature ☐ Free samples

name_____ title_____

company_____

address_____

city_____ zone____ state_____

For more data, see Chemical Materials Catalog Pages 330-334

MINERALS & CHEMICALS
CORPORATION OF AMERICA
3014 Essex Turnpike, Menlo Park, N.J.

Leaders in creative use of non-metallic minerals
ATTAPULGITE (*Attapulgus*)
ACTIVATED BAUXITE (*Porocel*)
KAOLIN (*Edgar • ASPs*)
LIMESTONE (*Chemstone*)
SPEEDI-DRI FLOOR ABSORBENTS

The Mail Box . . .

transport less than two persons but occupy the space of 40 pedestrians on the road.

The positioning of the operator more than halfway back to the rear of his car results in robbing him of his view of the road close up ahead and at the sides by the long, high hood, wide corner posts and bulging fenders. He can't help straddling lane lines. He must guess at every clearance and interval, especially if he is at all short-waisted. The operator can't see to drive his car efficiently, and that is one reason why the industry is now urging a $50 billion public expenditure for highways.

When chief executives of two makes of cars within a short time of each other are killed in separate accidents at the wheels of their cars, as has happened, it is evidence that these cars are not safe to drive. The mounting of the heavy engine at the farthest point from the wheels it has to drive and over the front wheels makes the car front-end-heavy and prone to skid and overturn when decelerated sharply in anything but a straight-line stop.

The reverse streamlining and use of an inverted chimney for exhaust results in venting the lethal carbon monoxide at ankle height where most likely to affect pedestrians and occupants of following cars.

In support of these faults in design of today's car, we are told that the auto industry builds what the people demand. This is a gratuitous assumption on the part of the auto manufacturers. The people have no say in car design. Today's 60 million automobile users are, from their very bulk, hopelessly inarticulate. The people can neither accept nor refuse what has never been offered. They take what the industry produces because they have to have transportation.

What is clearly needed, and must be done, is get the automobile makers to build and make available safer cars—especially driver-in-front, engine-in-rear cars that operators can see to drive safely.

The automobile industry knows how to make such cars. It is already making this type of vehicle. The driver-in-front, engine-in-rear urban and interurban buses which have been used for some twelve years have made a record, mile for mile of actual operation, of being from ten to fifteen times safer than the private passenger cars which all of us have no other choice than to buy.

We suggest that in order to get satisfactory results from your efforts you should call upon the auto makers to design and make available driver-in-front, engine-in-rear passenger autos.

Arthur W. Stevens
President, Automobile Safety Association
Boston

Handbook—Good Use

To The Editor:

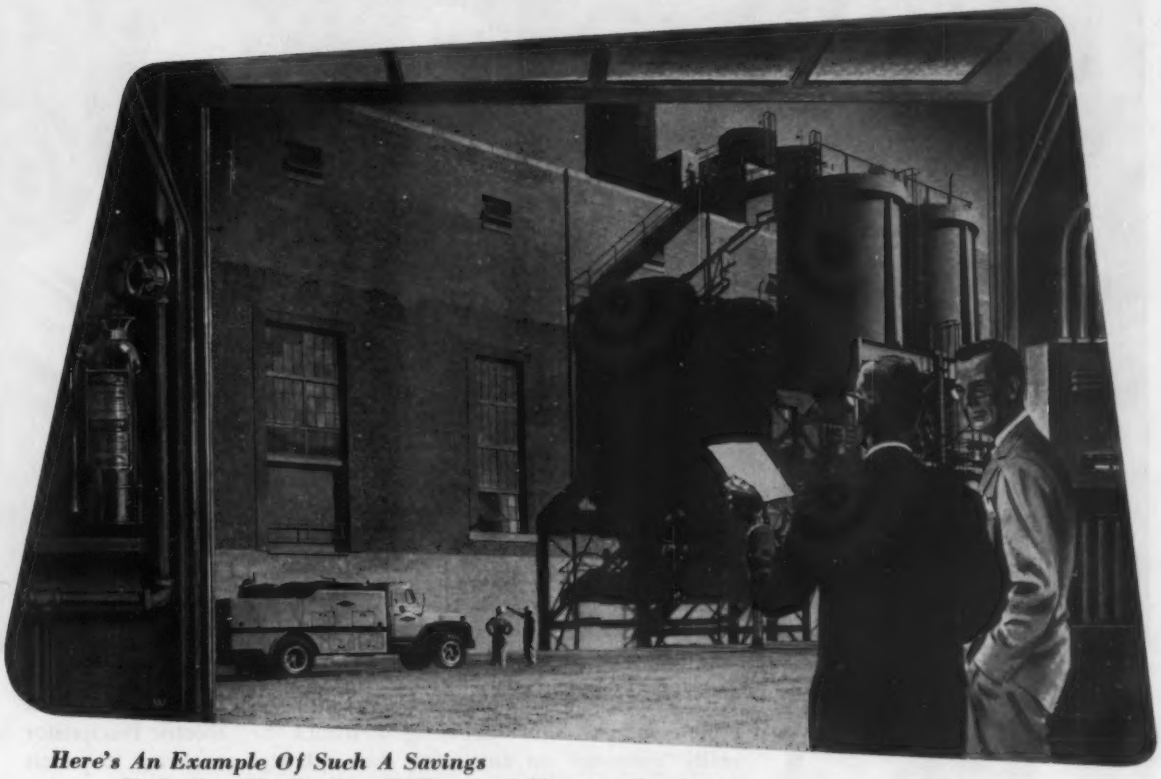
We would like to add our name to the many others from whom you have heard in complimenting you on the very fine job done in the production of the 19th Process Handbook, September, 1956.

We make frequent reference to this particular publication and have found that our salesmen put this information to good use in their respective territories.

H. W. Stoll,
Fluid Dynamics Section
Taylor Instrument Companies,
Rochester, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

how much could you add to your profit-- by saving $50,000 per boiler cleaning?



Here's An Example Of Such A Savings Made Possible By Dowell Chemical Cleaning Service

Dowell recently chemically cleaned a 1,000,000 lb. per hour steam generator for one of its customers. Total outage time was 48 hours. This saved the company an estimated five to seven days down-time, as compared to mechanical cleaning methods.

Considering replacement power for a boiler of this capacity costs between $7,000 and $15,000 per day, it's easy to see a $50,000 savings. And, it's just as easy to project a $250,000 to $500,000 annual savings for a plant with five to ten such boilers.

This particular case history concerns a power company with a forward-looking operations manager. But, Dowell has other startling performance data to show you — from your own industry. That's because chemical cleaning is so versatile. Dowell engineers are experts in removing scale and sludge from process systems, tanks and piping. They apply solvents in various ways— such as filling, jetting, cascading. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

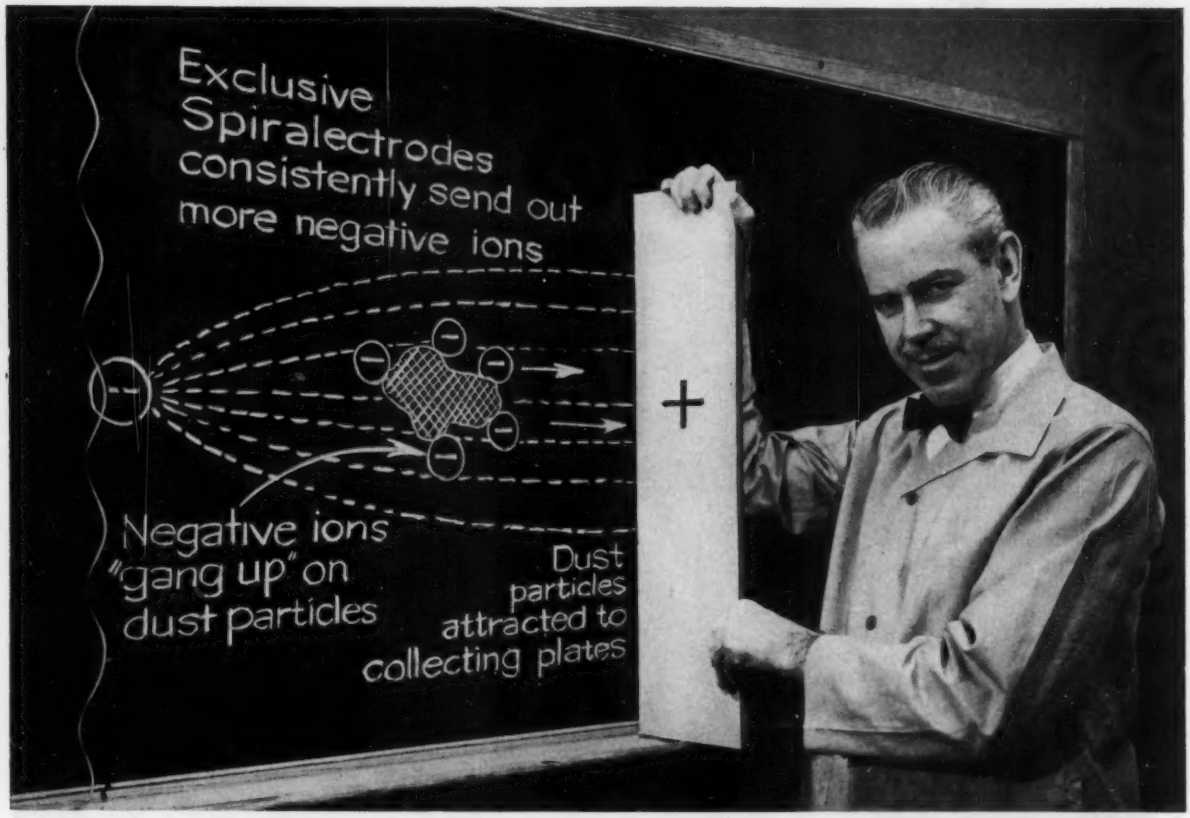
For specific information on how chemical cleaning can help you to greater profits, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

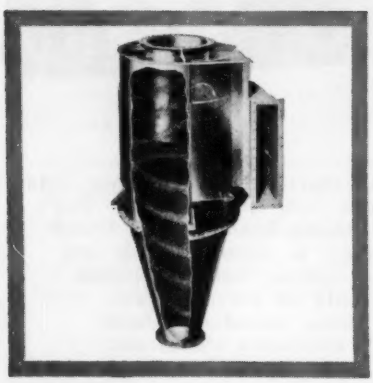
have Dowell clean it chemically DOWELL

A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

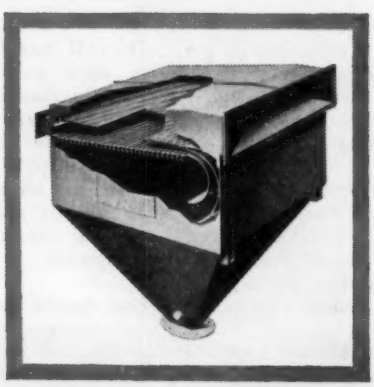
How a Buell Collection System "gangs-up" on dust to meet the toughest air pollution codes


Exclusive Spiralectrodes consistently send out more negative ions
Negative ions "gang up" on dust particles
Dust particles attracted to collecting plates



Buell Cyclones also deliver extra collection efficiency to "gang-up" on dust: Exclusive Shave-off design harnesses double-eddy current and puts it to work.

With positive gas flow control for peak efficiency . . . plus continuous cycle rapping to eliminate puffing . . . Buell's "SF" Electric Precipitator really "gangs-up" on dust (even dust with high resistivity) to permit full production even under the most rigid anti-air-pollution codes.



Buell's Low Resistance Fly Ash Collector combines high efficiency to meet present day strictness, with low draft loss for natural or mechanical draft installations.

FOR THE COMPLETE STORY
Write:

Buell Engineering Company
Dept. 21-E, 70 Pine Street
New York 5, New York

buell®

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

A Quick Look at the Industry THIS MONTH

Refining Outlook . . .

Industry report after six months of moving surpluses to Europe: For first time in two years, supply-demand-stock position of crude and products are "pretty well" in balance. By mid-April total stocks of crude and products were below 600 million barrels—about 90 million barrels under last October.

However, danger signs are still strong. Excessive imports and refining output must be curbed if current favorable price position is to hold.

Although accounting for small percent of total product output, refiner's Achilles heel appears to be mounting inventories of lube oils. Latest domestic-export demand forecast for '57 is 57.8 million barrels—about the same as '56. Inventories stood at 10.2 million barrels at beginning of '57 and are rising steadily—could become serious problem unless output is eased.

—•—

Refinery Wages Are Shaping Up . . .

Refining's '57 wage pattern is taking definite form. With some exceptions, contracts are being signed for 5 percent boost. Other benefits include eighth paid holiday, time-and-a-half for holiday work and four weeks paid vacation after 20 years.

Giant industrial unions are starting all-out campaign to unionize white collar workers. They have a fat target to shoot at: Only 225,000 of nation's 3.75 million industrial office workers are unionized. Group makes up about 12 percent of oil industry's personnel—and percentage is growing every year.

—•—

Postings on Octane Race . . .

Highest premium octane sample in April was 100.9 at Houston. National weighted average: 97.3, an increase of .3 over January. Highest regular octane average was Boston's 92.9.

After initial buying splurge, motorists are tapering off on third-grade gasoline. Result: Marketers are cutting tank wagon prices, going all out on promotion. Super duper grades now account for about 6 percent of all gasoline sales.

Octane race is expensive venture. Increasing premium gasoline from 98 to 110 research octane requires an increase in refining investment of 40 percent and an increase in manufacturing cost of 6 cents per gallon.

—•—

New Tool for Research . . .

California Research Corp. is using new type spectrophotometer that represents radical departure from old photographic process of determining chemical structures. Optical-electronic device records extremely weak radiation emitted by molecules on a strip-chart, with a pen and ink system. Advantages: Increases speed and accuracy in research on high octane gasoline, lubricating oil fractions and petrochemical products and processes.

—•—

Oil's Biggest Single Customer . . .

Uncle Sam's fuel costs are reaching astronomical proportions: Army aircraft fuel needs alone are averaging over half million dollars a day. In fact, fuel accounts for 20 percent of Strategic Air Command's total operating costs—almost $200 million in last fiscal year. Out of this total, $189 million was spent on aviation fuel and lubricants.

Navy's $38 million plant to make borax-derived high energy jet and missle fuel is well on its way to completion at Muskogee, Okla. Called "HiCal," product is said to provide 50 percent more energy per gallon than conventional petroleum fuels. Another $33 million plant is being built by Olin-Mathieson at Niagara Falls, N. Y.

New Trends in Asphalt Processes . . .

Look for new developments in asphalt processing. Solvent processes are getting a closer look; tailor-made asphalt even presents possibilities. Idea here is to re-proportion the asphaltenes, oils and resins which make up the chemical structure of asphalt.

Chances are new asphalt processes will tie in with upcoming $100 billion highway project. Recent estimates state needs for oil products over 13-year period of program will average $152 million annually.

—•—

All-Aluminum Engine Shows Promise . . .

Gas turbine talk has simmered down since new developments in piston engines have come forth. Look for an all-aluminum engine fitted with injection systems to get the next play. Advantages claimed for an aluminum engine: Cost reduction, some increase in hp/cu. in. and weight advantage.

—•—

Big Test for Free Pistons . . .

Free piston performance—compared with steam turbines, diesels, gas turbines—will be given major test this month. New type General Motors free piston engines will undergo rigorous trial run powering an old Liberty ship.

Attractions of free piston: Uses cheap fuel, promise of less down-time, less space and foundation requirements compared with diesels.

—•—

Gas from Coal— A New Process . . .

Bureau of Mine's new bench scale hydrogenation unit can directly convert up to 90 percent of sub-bituminous coal into gaseous hydrocarbons—mostly methane—within 15 minutes. Liquid end products are 58 percent benzene. Previous method to make high Btu gas involved making synthesis gas (carbon monoxide and hydrogen), then converting to methane.

Development is significant in that natural gas prices are rising and may become prohibitive for some uses within 10 years.

—•—

Trends in Residual Fuel . . .

Strong demand to use residual fuel in electric power generating power plants will continue for some years to come. Recent report reveals that U. S. electric power demand, instead of doubling every 10 years, as has been commonly believed, actually is doubling every 7 years.

Residual fuel oil demand for electric power plant fuel use has increased from annual rate of 62 million barrels in '52 to 68.5 million barrels in '56, an increase of 6.5 million barrels.

—•—

Ethyl Announces New Process . . .

Ethyl Corp. researchers have discovered new way to make tetraethyl lead. Could lead to many new metal-organic products. Still in lab stage, method is totally different from any ever used or proposed before—involves reactions between nonhalide lead compounds and metal-organics such as triethyl-aluminum, diethylzinc or ethyl sodium.

Advantages: Temperatures are mild—range from room to 100 C. Pressure is not needed. High yields. Does away with chlorine and sodium-lead alloy production.

—•—

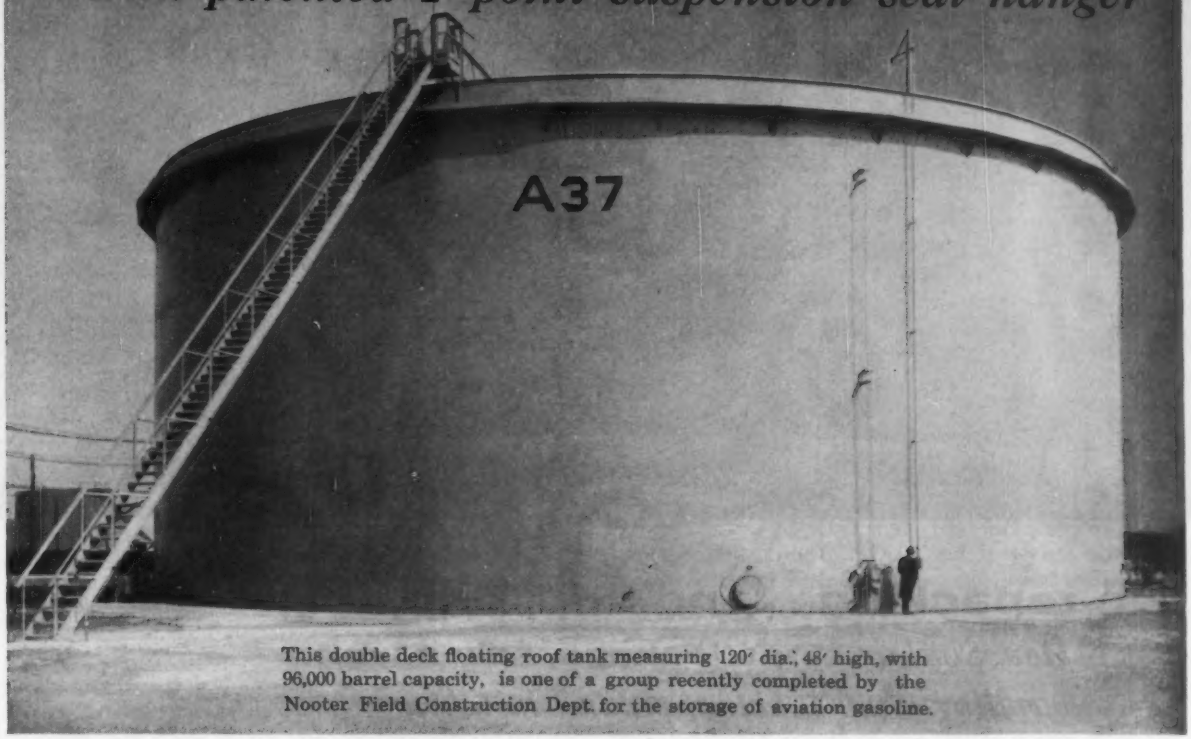
Oil Discoveries Appear Important . . .

Of the 52 new oil fields discovered in the U. S. during March, the following looked the best initially: Shamrock O&G's discovery in Hansford County, Texas Panhandle, flowing 2176 barrels of 39-gravity oil a day; Davis Oil's strike in San Juan County, Utah, testing 1680 barrels daily; Ohio Oil's Lea County, New Mexico, find rated at 408 barrels of 37-gravity; and Pan American Pet's Motley County, West Texas, well pumping 232 barrels of 43-gravity daily.

NOOTER announces...

new floating roof tank

with patented 2-point suspension seal hanger



This double deck floating roof tank measuring 120′ dia., 48′ high, with 96,000 barrel capacity, is one of a group recently completed by the Nooter Field Construction Dept. for the storage of aviation gasoline.

The floating roof oil and gasoline storage tanks fabricated and erected by Nooter are now distinguished by the new patented Nooter seal.

Because this seal exerts a uniform outward pressure over the entire height of the sealing shoe, a better seal is achieved, and abrasion at any one point is reduced.

Another important feature of the seal: all operating mechanism is placed beneath the roof, leaving the deck clear and neat.

The Nooter seal is adaptable, without size limitation, to double-deck, pontoon and pan-type roofs, or any existing type of floating roof.

For complete information on how the new Nooter floating roof tank can serve you better, write or call Nooter today. No obligation.

new NOOTER SEAL design offers you:

- **A simpler, more effective seal.**
- **Faster installation.**
- **Better radial alignment.**
- **Uniform outward pressure, less wear.**
- **Lower storage loss.**

Write for PLANT SURVEY REPORT No. 4
for a comprehensive report on NOOTER facilities.

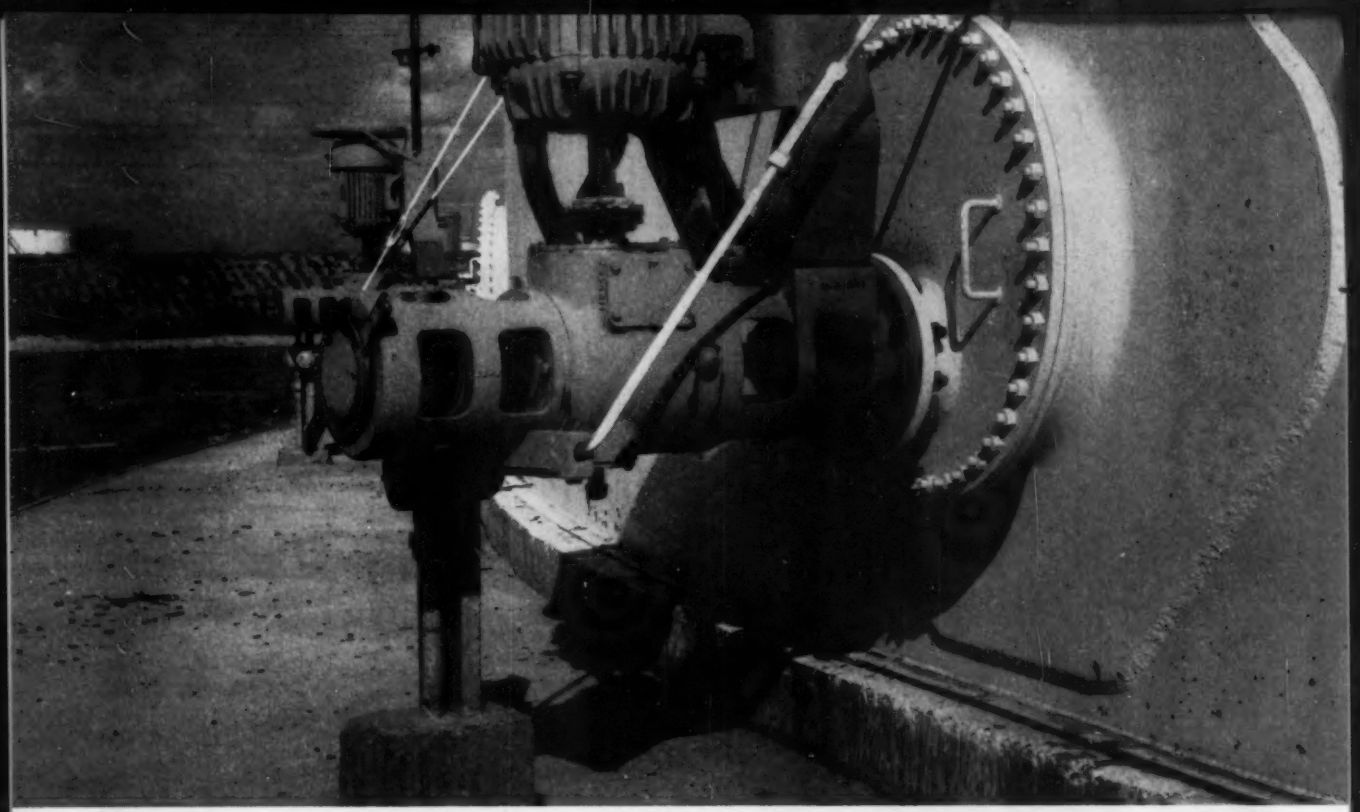
NOOTER CORPORATION

"Since 1896"

Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

1404 SO. SECOND ST. • ST. LOUIS 4, MO.

For more data on advertised products, use Readers' Service Cards, last page.



No repacking . . . no drip, drip, drip!

How Sinclair stops leakage, saves work

blending 150,000 bbl. of product in 6 hours

You can see, in this unretouched picture, how clean and safe Sinclair Refining Company keeps this product-blending operation, with the help of LIGHTNIN Mixers.

Tanks like this at Sinclair's Houston refinery hold 150,000 bbl. of finished gasoline. LIGHTNIN Mixers, three to a tank, blend the gasoline to full uniformity in just six hours. Not a drop gets through the LIGHTNIN rotary shaft seals!

Never need repacking

Even more significant is the saving—in time and maintenance cost—that Sinclair makes with mechanical seal-equipped LIGHTNINS. They *never* need to be repacked, *never* need shaft seal adjustment!

These LIGHTNINS have been in operation one year. "Maintenance requirements? Negligible!" say Sinclair's refining people.

You can save as much as 60% on big tank mixer maintenance with this newest LIGHTNIN feature. Year after year, you get dependable sealing, end stuffing-box repacking and adjustment for good.

Fast, easy replacement

And for the first time ever on side entering mixers, you can replace this seal *in a jiffy* if you ever have to!

Even under a full head of liquid in the tank, the seal-change job takes only minutes. No need to dismantle or remove the mixer from the tank. No special skill needed, either—it's a one-man, one-wrench job!

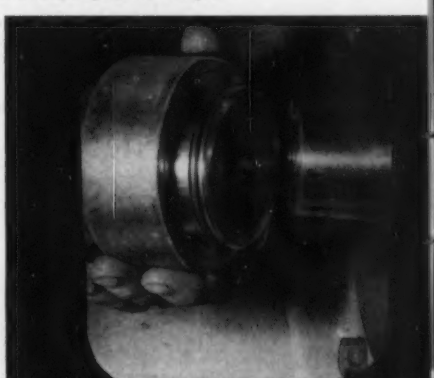
Available on all LIGHTNIN Side Entering Mixers, the LIGHTNIN seal cartridge is a unit assembly, easy to stock as a replacement or quickly obtainable in all sizes and materials for the simplest or toughest mixing conditions.

How much can *you* save? Your LIGHTNIN Mixer representative can give you the full story. Call him today—he's listed in Refinery Catalog. Or send the coupon for 8-page illustrated bulletin on LIGHTNIN seals and catalog information on LIGHTNIN Mixers.

Lightnin® Mixers

MIXCO fluid mixing specialists

SEAL SLIDES OFF mixer shaft, which uncouples to permit removal. New cartridge slides on. Taper on shaft insures correct realignment. Seal replacement is a fast, simple, one-man job.



☐ **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-e Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.

Standardization a Common Sense Goal

WASTE AND DUPLICATION are increasing their economic strangle hold on the petroleum industry. These menaces are promulgated by apathy on the part of the industry to **insist** that standards be applied to their processes, designs and methods.

Is this sudden cry for standards a new plea by harried, understaffed engineering departments? Was it born in the mind of management who see their inventories and maintenance crews expand yearly in chain-reaction-like suddenness?

To find these answers, let's see just what standards are. Basically, engineering standards are tools used by engineers to prepare a design without having to start with the bare fundamentals each time a similar design is required. First, there are process engineering standards, the methods of making and presenting calculations, data, flow sheets, symbols, reports, etc. The second group are called mechanical design standards—all of the equipment used in the refining and petrochemical industry, including various society codes. The third group involves construction standards, the methods and practices of construction that come under the influence of those persons interested in standardization. The last general group are termed maintenance standards. Any repetitive maintenance operation can be standardized to such a degree that dollars and time are saved.

Some may think everything is just about standardized now. True, a great many items are standard with a number of companies. But, for example construction companies and operating companies each go their own way as far as standard process calculations and presentations are concerned. Therefore, when operating management wants to evaluate construction companies' proposals, they must wade through several sets of standards. How much better it would be if the same procedures and presentations were universally used.

Symbols alone cause more confusion than is generally realized. Societies and industry alike are guilty in failing to find a common meeting ground in the use of symbols, although great strides are being made.

Calculation Methods. The greatest need perhaps is for the establishment of standard basic data on which all calculations can be based. In other words, a standard method of calculating heat transfer in exchangers would be helpful, but uniform physical data such as thermal conductivities would be a great step along the way. Any engineer could then vary his particular calculations so long as he used acceptable data and pointed out his reasons for selecting a certain calculation method. In turn, his results may be interpreted without having to question his basic data. Without such a base to work from, each method of calculation stands on its own merits depending on the persuasive ability of its advocate.

Mechanical Design. Many companies have made good progress in standardizing mechanical design. For example, in one plant all of the heat exchanger tubes were specified as one-inch O.D. And, they were standardized at either 20 feet long or some equal division of 20 feet, which gave them complete utilization of the standard 20-foot tube length. This far sighted firm expanded their standards policy and drilled all of their condensers and exchangers for two-pass flow even though many of them were installed with one-pass heads. The beauty of this system is that all of their tube bundles are readily adaptable to changing conditions. The principal value of mechanical design stands lies in the elimination of repetitive engineering. (Here, too, is one of the answers to "the engineering shortage.")

Piping drawings have been the subject of more standardizing efforts than perhaps any other single phase of activity. But one of the prime difficulties is that one company's designations when interchanged among other companies produce confusion and loss of time. For example, it is common practice for every company to assign a standard classification *letter* for various services involved. The result is that when the men of two companies get together on a project of mutual interest, much time is required before each is familiar with the other's designations. How much simpler it would be if everyone used the same piping and equipment classifications.

Construction Standards. How many times have you heard arguments as to whether a structure should be all welded or bolted construction? How many times a discussion on the qualities of galvanizing or non-galvanizing? Each plant has its values of these techniques for a particular structure. This produces extra costs in engineering design and fabrication, since each structure is essentially custom designed according to the whims and ideas of the engineer in

NOW... pre-mixed additives offer new convenience to refiners

NEW combination prevents gel-clogging in fuel lines as well as sludge-plugging of filters, screens and nozzles

Now Du Pont offers the protective qualities of two additives, pre-mixed for your convenience: Fuel Oil Additive No. 2 (FOA-2) and Du Pont Metal Deactivator (DMD). Respectively, they provide outstanding stabilizing and dispersant action, and protection against the effects of copper contamination.

The result is a solution that guards against practically all the major chemical causes of oil burner troubles and failures.

The new additive is available in two different concentrations. One, FOA-208, is composed of 8% DMD and 92% FOA-2. The other, FOA-212, is a 12% DMD, 88% FOA-2 solution.

Stabilizer and dispersant

The stabilizing action of Du Pont FOA-2 retards the formation of insoluble residues during bulk storage and in customers' tanks. The dispersant action of FOA-2 reduces the size of the particles in any residues that may form.

In these two ways, it prevents a build-up of sludge that causes clogging of filters, screens and nozzles.

Prevents gel-clogging

Clogged fuel lines are generally due to the formation of a gelatinous material. This is frequently caused by contamination from copper in screens, feed lines, valves and other fuel handling equipment. DMD prevents this effect of copper contamination . . . thus preventing the need for many service calls due to gel-clogged fuel lines.

Now, it is possible for refiners to add this complete three-way protection in a single operation. For best results, Du Pont FOA-208 or 212 should be added to freshly prepared stocks at the refinery.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. ... RAndolph 6-8630
Cleveland 15—25 Prospect Ave. ... SUperior 1-1363
Denver 2—510 Mile High Center Bldg. . AComa 2-2347
Houston 2—
705 Bank of Commerce Bldg. .... CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 5-1691
New York 20—
1270 Ave. of the Americas ..... COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center .. ATlantic 1-2933
San Francisco 4—111 Sutter St. .... EXbrook 2-6230
Seattle 3—4003 Aurora Ave. ..... MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. .... LUther 5-5578
In Canada—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario ..... HUdson 1-6461
In Other Countries—Petroleum Chemicals Division, Export Sales, 7496 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962

DU PONT
REG. U. S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.)—Petroleum Chemicals Division, Wilmington 98, Delaware

charge. It is a known fact that identical process units cost some companies up to 25 percent more than others. This is an example of carrying standards too far, or not keeping them up to date. One of the larger companies claims that the life of a mechanical or construction standard without revision is only 2 or 3 years.

Maintenance Standards. The complexities of modern refining and petrochemical plant operations have elevated the maintenance departments to a new position of importance. This phase of a plant's activities certainly demands positive application of standardization techniques. Any repetitive maintenance method can and should be standardized. One plant, after studying its techniques, was able to cut in half the time required to pack a valve. This program represents real money and an opportunity to reduce maintenance costs in the face of a rising economic squeeze faced by every petroleum processor. Wouldn't it be better if all repetitive maintenance operations were studied and industry standards recommended so that future maintenance costs could be held at a minimum?

What can you do about standards? You can become familiar with your own plant, its method of operation, and its equipment. Keep an eye open for repetitive procedures that could be standardized. Be on the lookout for an opportunity to tell management that *industry-wide* methods and specifications are the only real solutions to such problems. You can support the technical societies' efforts to bring about standards that are acceptable to everyone in the industry. You can advise manufacturers, through their representatives, that your industry is interested in more universal standardization of equipment. Urge them to cooperate with industry and the societies in adopting standard dimensions and materials in the manufacture of their products. It's up to the engineers of the petroleum industry to *insist* that the waste and duplication of time and money are reduced through the adoption of industry-wide standards. Above all they should use the standards that are probably gathering dust on their bookshelves right now!

Refining or Chemical?

Is refining an industry? There are some who seem to doubt it—including our federal government. The U. S. Bureau of the Budget is trying to eliminate its "Products of Coal and Petroleum" classification, using "Basic Chemicals" instead. Petroleum refining would be included under the new title.

If this change does come about, government statistics will be virtually worthless to refiners without a detailed breakdown. Few people outside the industry will have access to the true refining picture, since they don't usually have need for such breakdowns. In short, one of the nation's greatest enterprises would be completely ignored as an industry.

The confusion is compounded with the realization that the API has been trying for years to get refining to stand alone in Budget Bureau classifications—obviously with little success. Some one has slipped up somewhere, for the new heading would make refining an even greater non-entity than the Bureau's present "Products of Coal and Petroleum" classification.

The refining industry itself may be somewhat to blame for this situation. Perhaps not enough interest has been shown to convince government officials that refining should stand alone in industrial classifications. Perhaps the traditional pride that refiners have for their industry has not come forth with enough enthusiasm.

Whatever the reasons, the new classification will be a boon to the chemical business—if it is adopted.

The least that refiners can do is to speak up—and speak loud enough for the Budget Bureau to hear their side of the issue. You can bet your last octane the chemical boys are being heard.

Needed Refinery Cuts Being Made

DURING THIS relatively low petroleum-demand second quarter, the U. S. refining industry is doing a good job of tailoring its operations to fit the situation. It was a little slow in making the downward adjustments, but recent industry statistics show refinery output has been lowered to a better relationship with needs than was true a short time back.

In order to keep petroleum product markets firm, current reduced output levels should not be raised within the next two months. Present gasoline and distillate fuel oil inventories are higher than they need to be, but the outlook is now more encouraging. However, further refining reductions are needed to put these into stronger market position.

Back at refiners' basic source, crude oil markets are perhaps the strongest they have been in years due, to a large extent, to heavy shipments to Europe during the Suez emergency siphoning off excess supplies. These markets are further strengthened by producing rates in the principal producing areas being carefully regulated to fit needs. Output in April was reduced and will be further lowered in May. This is in line with the seasonal decline in oil consumption and reduction in European shipments.

Gasoline stocks are beginning to be whittled, but they are not being dropped as fast as they were a year ago at this time. This is due to greater output this year, and not from lessened consumption. Late in April, these stocks amounts to 200 million barrels, which was 10 million barrels more than was being held a year earlier. This 10-million-barrel margin was not as encouraging as was the 8-million-barrel difference reported only two weeks earlier. However, present differential is no more than existed early in March when the record-total of 205¾ million barrels of gasoline was in the nation's tanks.

Also on the high side are distillate fuel oil stocks. Late-April inventory placed these at almost 75 million barrels, which meant that they were standing 13 million barrels over year-before levels.

However, this situation can be further improved during May if gasoline output is held to a little under 3,700,000 barrels a day and distillate to 1,700,000 daily. The last two weeks in April saw gasoline average 3,750,000 and distillate 1,735,000 barrels a day.

Ethyl research gains the spark

Unique instrumentation assures positive detection of misfiring

This Misfire Recorder accurately detects misfiring and records spark plug shunt resistance during a rating test. Pressure pulses in the exhaust system due to misfiring are picked up by a transducer and relayed to the instrument. Spark plug resistance is measured by a built-in megohmmeter.

This type of instrumentation was first applied to the detection of spark plug misfiring by Ethyl Research Laboratories. It has proved so satisfactory that many leading petroleum and automotive companies are now using the same instrumentation in their own laboratories.

For more data on advertised products, use Readers' Service Cards, last page.

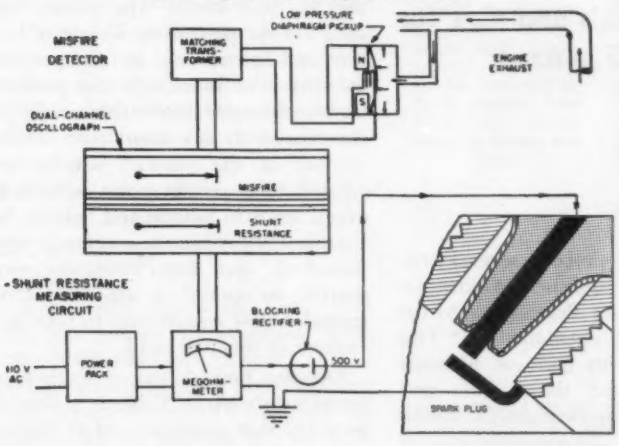
new insight into plug fouling problem

IT'S BEEN EVIDENT for some years that trends in engine design, as well as trends in urban and suburban traffic patterns, are intensifying the problem of spark plug fouling in passenger cars.

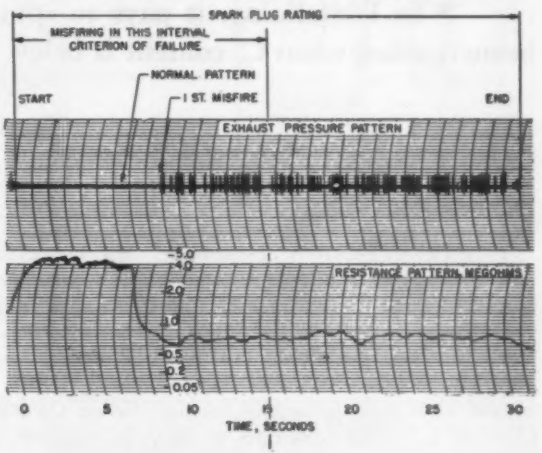
In the process of developing additives to help combat this problem, it became obvious to Ethyl engineers that previous laboratory methods for detecting and measuring spark plug misfire were inadequate. So Ethyl engineers created their own instrumentation—the unique device at the left.

Below is a diagram of the equipment, as well as a picture of the record this instrumentation produces when the transducer and megohmmeter outputs are fed into a dual-channel oscillograph:

Block Diagram of Spark-Plug Instrumentation



Actual Misfire and Shunt Resistance Patterns of a Fouled Spark Plug



How Ethyl Research can help you

Because of its extremely close relationship with both the Petroleum and Automotive Industries over the years, Ethyl Corporation has been able to channel much of its research effort into projects of unusual interest and importance to both industries.

Many new instruments and techniques have been developed and a great storehouse of data on fuel-engine relationships has been produced. For further information, just call your Ethyl Representative.

ETHYL CORPORATION
New York 17, N. Y.

ETHYL ANTIKNOCK COMPOUND ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

1957 API Meeting . . . *the time to upgrade fractions*

Big talk at API's Refining Division meeting this year was how to get those top octanes for future motor fuels. The fraction in the refiner's gasoline pool that's getting the most attention is the pentane and hexane stream. Most popular way to handle this is isomerization. But other ways are being looked at—catalytic dehydrogenation and dehydrogenative reforming. You'll find these described in this special report.

The question now in refiners' minds is when to add isomerization—now or when catalytic reforming has reached its potential. You'll find excellent economic studies in this issue telling how much isomerization will cost and at what point it should be added. Further, you'll find one article which tells how a typical refinery can meet 110 octane premium in the future.

For the catalytic reforming corrotion problem, one committee has

isomerization

When to Isomerize Pentane and

• Hypothetical case shows that isomerization should be added when gasoline pool reaches 97.8.

• In Pentafining, it pays to split C_6's and C_5's for isomerization when C_6 content is below 55 percent.

H. R. Grane, J. K. Ozawa and G. R. Worrell
The Atlantic Refining Company,
Philadelphia

THE CONVERSION of *n*pentane and *n*hexane to their isomers gives a very substantial octane increase. The Pentafining process effects this isomerization with little yield loss. The selectivity of the catalyst is demonstrated with once-through yields for C_5's and C_6's. The economics of isomerization are clarified by showing applications to several typical refinery situations.

Since March 1956, when The Atlantic Refining Company announced the Pentafining process, several articles have been published to illustrate the application of Pentafining to the isomerization of *n*pentane.[1,2,3,4] This discussion presents data on *n*hexane isomerization and shows how and when C_5 and C_6 Pentafining should be installed in a typical refinery.

Catalyst Performance. Pentafining catalyst is a combination of platinum, silica, and alumina specifically designed for isomerization operations. The performance is shown by Figure 1, where once-through yields and quality of product are plotted for C_5 and C_6 feed stocks. The parameters used are the percent by weight of butane and lighter yield and the percent by volume of isomers in the product having the same molecular weight as the charge. It is evident that isomer content of the product can be increased to a certain point with only minor losses to butane and lighter. As chemical equilibrium is closely approached, gas loss increases very sharply, so operations are conducted enough below equilibrium to take advantage of the high yield.

Detailed breakdowns of single-pass yields are shown in Table 1. It should be noted that production of all hydrocarbons lighter and heavier than the charge is minimized.

TABLE 1
Typical Once-Through Yields from Pentafining

Feed	*n*Pentane		*n*Hexane	
YIELDS	Percent By Weight	Percent By Volume	Percent By Weight	Percent By Volume
Methane	0.1	....	0.1	....
Ethane	0.1	....	0.2	....
Propane	0.1	....	1.2	....
*Iso*butane	0.1	....	0.2	....
*n*butane	0.6	....	0.3	....
*Iso*pentane	58.9	59.5	0.1	....
*n*Pentane	39.6	39.6	0.9	....
*Iso*hexanes	0.5	....	67.3	68.0
*n*Hexane			29.5	29.5
C_7 and heavier	0	....	0.2	....
Total	100.0	99.1	100.0	97.5
C_4 and lighter, percent by weight	1.0		2.0	
Isomers in product, percent by volume	60.0		70.0	

Process Design. Because of the number of different hydrocarbons to be considered in a C_5 and C_6 feed stock, detailed calculations are required to establish the optimum processing scheme. Figure 2 is a flow diagram of Pentafining and some of the associated fractionation, which illustrates a few of the possibilities. Separate C_5 and C_6 streams may be processed in the manner shown. Each stream, for instance, could be charged to a splitter to concentrate the *n*paraffins, or could be charged directly to the Pentafiner. After isomerization the product could be recycled to the splitter

in gasoline pool

made an excellent survey of current data which you will find in this report.

Other sessions at this meeting considered the problems of electrical equipment, air pollution, training, instrumentation, and analytical research.

CONTENTS

172 When to Isomerize Pentanes and Hexanes
177 Isomate Process Adapted to Motor Fuel
183 Upgrading With Dehydrogenization
186 Upgrading Saturates With Reforming
189 How Humble Runs Catalytic Reformers
193 How to Make 110 Octane Premium
199 Low pH vs. High pH in Crude Oil units
201 Survey Reveals Reformer Corrosion Data
205 Gas Chromatography Steps Out

Hexane Fractions

or taken directly to gasoline blending. In addition, C_5 and C_6 *n*paraffins could be isomerized in the same reaction section if economics so dictate.

Figure 3 illustrates one phase of the calculations to determine the optimum way to process the C_6 fraction. Typical feed stocks of varying *n*hexane content were calculated through two routes:

1. Once-through Pentafining without prior fractionation.
2. Once-through Pentafining after splitting.

Investment, operating cost, yield loss, and octane improvement were calculated and incorporated into a cost measured in cents per barrel for each Research octane-number increase with the addition of 3 ml TEL per gallon. The cost of fractionation to separate the C_6 fraction from crude oil is common to both routes and is not included. The cost in cents per barrel for one octane number is plotted against the *n*hexane concentration in the feed.

It may be seen that the break-even point occurs at approximately 55 percent *n*hexane. At higher concentrations there is an advantage in passing the total feed through the Pentafiner. At lower concentrations there is a substantial driving force for splitting first. Ring compounds such as benzene, cyclohexane, and methylcyclopentane do not markedly affect this conclusion, provided that the *n*hexane

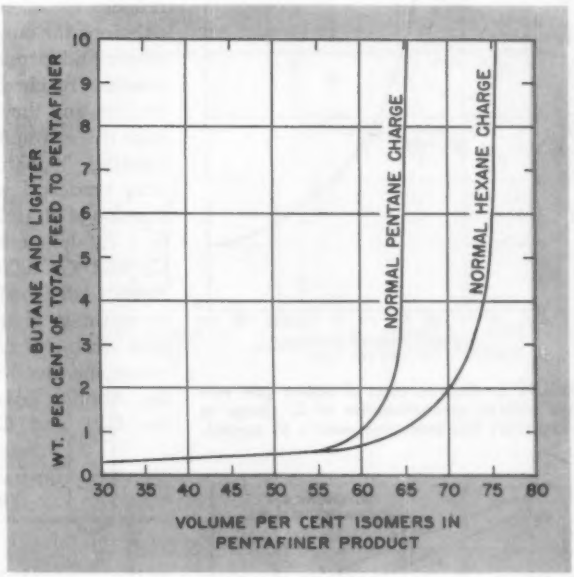


FIGURE 1—Pentane and hexane isomerization data: Isomer content of product can be increased up to a certain point with only minor losses to butane and lighter.

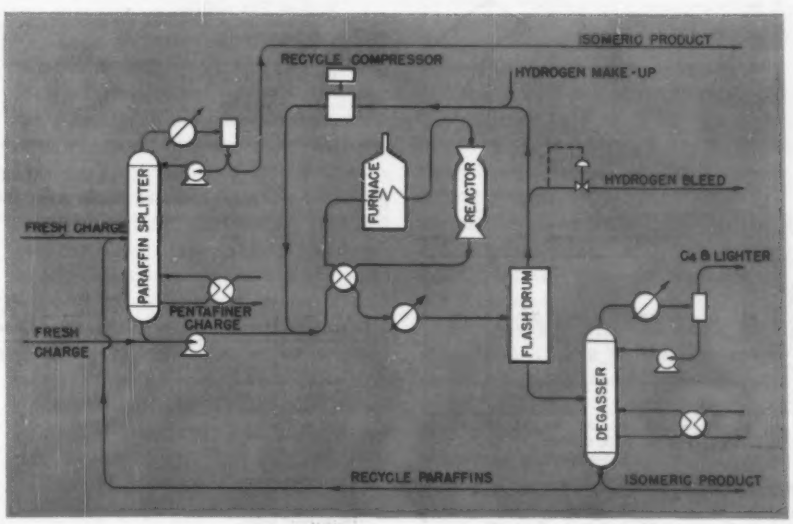


FIGURE 2—Flow scheme for Pentafining Process: Separate C_5 and C_6 streams may be charged to a splitter or directly charged to the unit.

content of Figure 3 is expressed as a percentage of the C_6 paraffins in the feed.

Ultimate Yields. In most cases, pentanes will be processed in a recycle operation to a 99 to 100-percent yield at 95 percent *iso*pentane.

Typical over-all yields, RVP (Reid vapor pressure) change, and octane improvement for C_6 Pentafining are shown in Table 2. The Mid-Continent paraffinic C_6 fraction was processed once-through without splitting because of the high percentage of *n*hexane. The product octane and yield are relatively low, but the octane-number improvement is 13.8 with the addition of 3 ml TEL per gallon. The other two stocks were split before Pentafining because of their lower *n*hexane contents.

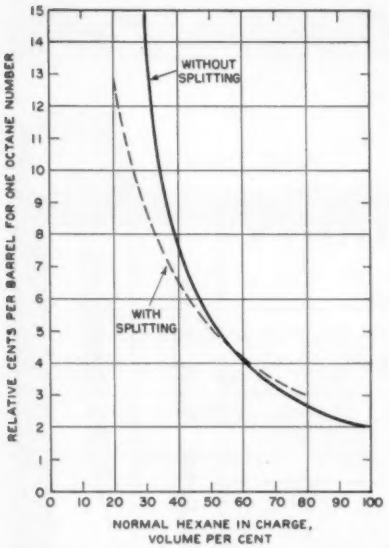

RELATIVE CENTS PER BARREL FOR ONE OCTANE NUMBER
WITHOUT SPLITTING
WITH SPLITTING
NORMAL HEXANE IN CHARGE, VOLUME PER CENT

FIGURE 3—Relative costs of octane gain with and without prefractionation of C_6 charge to Pentafiner: The breakeven point is 55 percent.

When Does Pentafining Become Attractive? With this basic information, it is possible to evaluate Pentafining to determine whether isomerization of C_5 and/or C_6 paraffins can be economically justified in a given refinery situation. We have made calculations for our own refinery and for several independent refiners. The conclusions reached in each study are similar, and they may be summarized with this example. Consider a refinery running 30,000 barrels per day of Iraq crude oil with the C_7 to 380-F fraction of straight-run naphtha going to a catalytic-reforming unit, and the C_5 and C_6 light naphtha going directly to finished gasoline after caustic washing. If an increase in gasoline pool octane is required, one may increase the severity of catalytic reforming. Another possibility is to isomerize the C_5's and C_6's before blending them back into the gasoline pool, as indicated schematically in Figure 6.

The yield of debutanized gasoline and the final octane levels are shown at the top of Figure 4 for the two cases. The lower line is the yield-octane relationship achieved by Catforming the C_7 to 380-F fraction from Iraq crude oil and blending back the raw C_5's and C_6's, while the upper line represents the final blend of the same Catformate with the Pentafined C_5 and C_6 streams. If the present pool octane number is 93 with the addition of 3 ml TEL per gallon, and it is desired to produce a pool with a 94 Research octane number, one can go from *A* to *B* by increasing severity or from *A* to *C* by installing and operating the isomerization facilities. Similarly, if the pool is to be increased from 97 to 98 octane, one could increase reforming severity from *D* to *E* or move from *D* to *F* with isomerization. In moving from *D* to *F* there is a yield advantage of 1.5 percent of the total feed, as well as a credit for Catforming catalyst cost because of the lower reforming severity required. These credits (which are higher at the higher octane level) must be balanced against the operating and investment costs for the Pentafiner.

The calculations were made over the entire octane range to determine the cost of getting *one* incremental

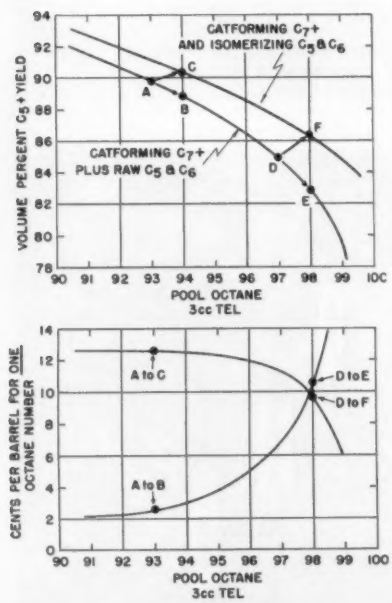


FIGURE 4—Upper chart: Yield-octane comparison of combined Pentafining-Catforming and Catforming alone; Lower chart: Comparative costs by these two methods of operation as a function of total pool octane level.

TABLE 2
Yields and Octane Improvement from C_6 Isomerization

	Mid-Continent Paraffinic	Mid-Continent Naphthenic	Middle East
C_6 Charge:			
ASTM octane number (D 908, Research Method):			
Without TEL addition	46.8	66.6	59.8
With addition of 3 ml TEL per gal	78.0	89.4	85.6
Reid vapor pressure, lb	5.2	5.2	5.4
C_6 Product:			
ASTM octane number (D 908, Research Method):			
Without TEL addition	70.4	76.2	73.3
With addition of 3 ml TEL per gal	91.8	95.0	93.3
Reid vapor pressure, lb	6.1	5.6	5.9
Charge, percent by volume	94.3	97.3	96.5

TABLE 3
Inspections of Stocks Available for Processing and Blending

	Pentane From Crude Oil	Hexane From Crude Oil	C_7 to 380-F Straight-Run Naphtha	Debutanized Catformate from C_7 to 380-F Straight-Run Naphtha	Debutanized Catalytically Cracked Naphtha
Barrels per day	1,050	900	7,350	5,880	6,000
ASTM Octane Number (D 908, Research Method):					
Without TEL addition	77.3	54.0	40.6	92.4	92.3
With addition of 3 ml TEL per gallon	94.0	82.1	....	100.0	98.0
Reid vapor pressure, lb	....	5.7	0.8	4.3	4.1
ASTM distillation, deg F:					
Initial boiling point	....	....	196	125	114
10-percent point	....	....	220	174	150
30-percent point	....	....	255	225	205
50-percent point	....	....	283	267	254
70-percent point	....	....	310	305	296
90-percent point	....	....	342	347	360
End Point	....	....	382	395	402

octane number on the pool by both methods of processing, and the results are summarized in the lower half of Figure 4. Gasoline-yield loss to butane and lighter was valued at 7 cents per gallon differential. The Pentafining investment, which included the pentane splitter, depentanizers, dehexanizer, and all auxiliary equipment, was written off over a four-year period. Operating costs include utilities, catalyst, maintenance, labor, and royalty.

The cost of 1 incremental octane number by moving from point *A* to point *B* (higher reforming severity) is 3 cents per barrel, as compared to more than 12 cents per barrel by going from *A* to *C* with isomerization. The cost of one incremental octane number at higher levels, however, shows that it is desirable to include isomerization facilities and take the *D* to *F* route rather than from *D* to *E* with increased reforming severity alone. In this case, to reach a pool Research octane number of 97.8, it becomes economical to meet the specifications by the combination of Catforming and Pentafining.

Today many refineries are approximately one-half to one octane below the crossover point in send-out pool octane. At that level it costs an extra 3 to 6 cents per barrel of octane for isomerization over reforming alone. However, as octane levels move up slightly, one can readily justify paraffin isomerization; and when the octane requirement gets only one-half octane above the crossover point, it is extremely uneconomical to rely on high-severity catalytic reforming alone. Inasmuch as an increase of less than one octane in the gasoline pool can affect the economics so substantially, it is important to properly study the problem and plan well in advance.

Comparison of Pentafining with Selective Blending. In the example just presented, the point at which Pentafining can be justified is 97.8 pool octane, which corresponds to an octane number of approximately 100 with the addition of 3 ml TEL per gallon for the Catformate product before blending with the C_5 and C_6 streams. To distinguish between total refinery pool octanes and send-out octanes for regular and premium gasolines, 2 processing schemes have been studied to reach a 101-octane premium fuel—Case I without Pentafining and Case II with Pentafining.

The refinery naphtha streams for gasoline blending consist of the 100-octane debutanized Catformate, the C_5 and C_6 stream from crude oil, and the debutanized catalytically cracked naphtha, as shown in Table 3. A block diagram for Case I is shown in Figure 5. This scheme, which is used in Atlantic's own refineries, concentrates the high-octane components in the premium gasoline. In this example the Catformate is fractionated into an aromatic-rich bottoms with a 102 Research octane-number blending value and a light Catformate with a 96.3 octane-number rating. Then the cat naphtha is also fractionated into overhead and bottoms cuts with the light cat naphtha being 2 to 3 octanes higher than the bottoms. By blending the high-octane Catformate bottoms and the high-octane cat naphtha overhead, a premium gasoline is obtained with good volatility properties and with a CFR extension octane number of 101, higher than either of the starting components. The regular gasoline contains the Catformate overhead and the heavy cat naphtha, as well as the straight-run C_5's and C_6's.

Case II includes Pentafining of C_5 and C_6 paraffins, as shown in Figure 6. The straight-run naphtha is dehexanized before going to the Catformer, as in Case I. The Catformate product is also depentanized after stabilization, and the combined C_5's from crude oil and from Catformate go to the Pentafiner where they are converted to 95 percent *iso*pentane in a recycle operation. The hexanes from the crude oil go to a very simple once-through reactor where they are isomerized to essentially equilibrium composition.

The depentanized Catformate and the 95 percent *iso*pentane make up the premium gasoline pool. In these calculations, an octane number of 103.0 for 95 percent *iso*pentane with the addition of 3 ml TEL per gallon has been used. Although higher values have been reported in the literature, Atlantic data show that 103.0 is a better blending value in high-octane components. The regular gasoline consists of the total cat naphtha and the hexane product.

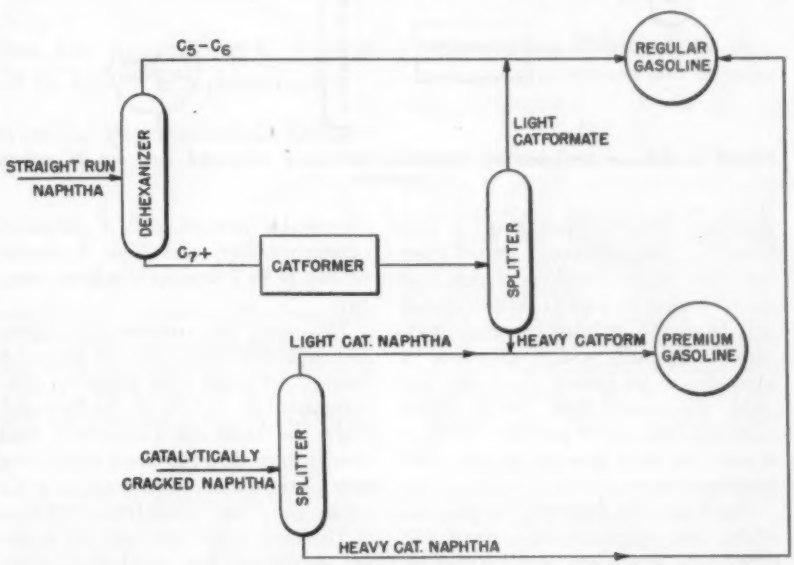


FIGURE 5—Scheme for producing premium and regular gasoline by selective fractionation of catalytic reformate and catalytic-cracker gasoline. (Case I)

To compare the two cases, all of these blends have been made at constant reforming severity, with maximum TEL, and to a constant yield and Research octane number of the premium gasoline. The variation occurs in the regular. The composition and properties of each blend are listed in Table 4.

There is a small difference in total

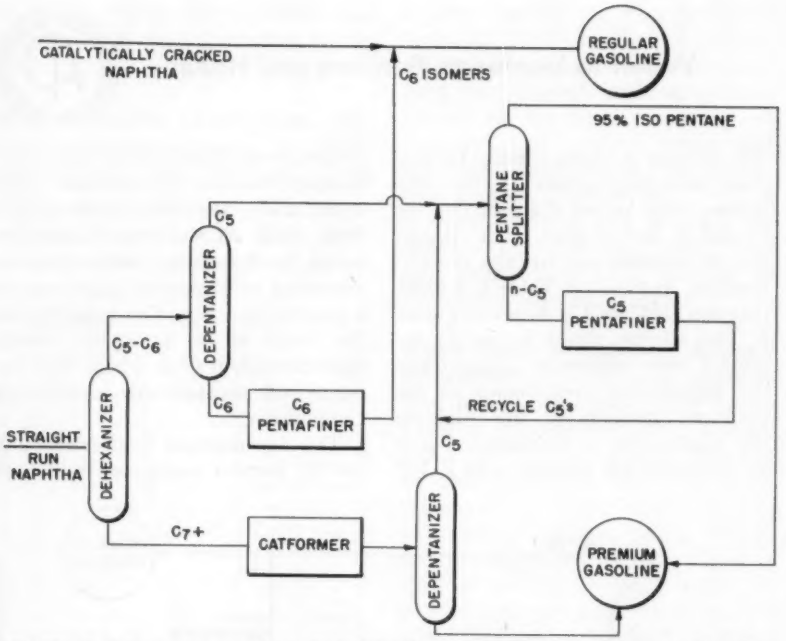


FIGURE 6—Scheme for combined Pentafining-Catforming integrated into over-all refinery operation.

About the Speaker

H. R. GRANE joined Atlantic Refining Co. after receiving his M.S. degree in chemical engineering in 1949 from Massachusettes Institute of Technology. For the past four years he has worked on operating and process problems related to commercial Catforming operation. Grane is now a member of the licensing section of Atlantic's Research and Development department.

gasoline yield between Case I and Case II. This difference results from the very slight cracking losses that occur during C_5 and C_6 isomerization and from the increase in vapor pressure associated with converting a *n*paraffin to an isomer. As shown, the yield difference that results from cracking and vapor-pressure increase is only 0.6 of 1 percent of the total gasoline volume.

The volatility properties of the gasolines are approximately equal for both cases. Inasmuch as the Research octane numbers have been held constant for the premium, all of the octane increase from isomerization shows up in the regular blends. Case II regular octane is 97.1 Research octane number, and Case I regular octane is 94.7 Research octane number.

However, the road-octane ratings are quite different from the Research ratings. Although both premium mixtures rated *iso* +0.09 on the Research scale, the Modified Uniontown road ratings show that the blend containing only Catformate and *iso*pentane is 3.2 octane numbers higher than the blend of Catformate bottoms and cat naphtha overhead. The road ratings are three car averages from Cadillac, Lincoln and Buick. Essentially what has been done is that the components with high road ratings have been concentrated in the premium fuel. Although there is not complete agreement on the evaluation of road octanes, it is true that road octanes best indicate the performance of the fuel in an automobile. If we assume the cost of 1 octane at the 100+ level is 12 cents per barrel, the 3.2 octane-number advantage achieved is worth 38.4 cents per barrel. Of course, the loss of some road octane in the regular pool must be taken into account, but at the lower octane level, the cost per barrel for one octane is appreciably lower.

Another method of evaluating the higher road-octane rating is to reduce the Catforming severity in Case II until the premium pool has the same road octane as Case I premium, and then to calculate the yield advantage and catalyst cost savings obtained. At 99.3 road octane number, the 10-lb RVP premium-gasoline yield increases from 7290 to 7883 barrels per day. This higher yield (valued at 7 cents per gallon differential) and the lower operating costs give a net savings of $2199 per day.

Original presentation was before the American Petroleum Institute, Division of Refining, Philadelphia, May 13-16, 1957.

TABLE 4
Comparison of Blends

	PREMIUM GASOLINE Case I (Percent)		Case II (Percent)	
	Catformate bottoms	52.2	Depentanized Catformate	72.9
	Cat naphtha overhead	37.9	95 percent *iso*pentane	22.0
	Butane	9.9	Butane	5.1
Total barrels per day	7,290		7,290	
Reid vapor pressure, lb	10.0		10.0	
Percent at 212 F	37.0		36.0	
ASTM octane number (D 908, Research Method):				
With addition of 3 ml TEL per gal	101.0 (*iso* + 0.09)		101.0 (*iso* + 0.09)	
Modified Uniontown road octane	99.3		102.5 (*iso* + 0.28)	
	REGULAR GASOLINE Case I (Percent)		**Case II (Percent)**	
	Catformate overhead	27.1	Total cat naphtha	79.4
	Cat naphtha bottoms	42.3	*Iso*hexane stream	11.5
	C_5 and C_6 crude oil	25.5	Butane	9.1
	Butane	5.1		
Total barrels per day	7,650		7,560	
Reid vapor pressure, lb	10.0		10.0	
Percent at 212 F	46.0		46.0	
ASTM octane number (D 908, Research Method):				
With addition of 3 ml TEL per gal	94.7		97.1	
Modified Uniontown road octane	95.5		96.1	

LITERATURE CITED

[1] G. R. Worrell. "Pentafining," *Oil Gas J.* 54 [46] 183 (1956).
[2] G. R. Worrell. "Now 100 Octane from Natural Gasoline," *Petroleum Refiner* 35 [4] 138 (1956).
[3] G. R. Worrell. "Progress Report on Selective Isomerization," *World Petroleum* 27 [8] 74 (1956).
[4] "Isomerization of Normal Paraffins," *Petroleum Processing* 11 [10] 101 (1956).

Isomate Process Adapted to Motor Fuel

• This isomerization process for upgrading C_5's and C_6's uses $AlCl_3$ complex catalyst at lower temperatures.

• Cost case is developed for using isomerization before catalytic reforming potential is reached.

H. G. Krane and E. W. Kane
Standard Oil Company (Indiana),
Whiting, Ind.

ADVANTAGES of low-temperature isomerization are attainable with the very active catalyst used in the Isomate process.[3,4] Developed during World War II to supply aviation gasoline, this process has been improved and adapted to motor-fuel needs. An isomerized light naphtha of 96 to 98 Research octane number, leaded, can be produced without recycling. When higher octane ratings are desired, a product of up to 106 octane number can be obtained by recycling. (All octane numbers greater than 100 are expressed by the Wiese extension of the octane scale.[1])

As normally carried out, isomerization reactions are rapid and approach chemical equilibrium. The octane number of the product is therefore controlled by its equilibrium composition and is strongly dependent upon temperature. Low temperatures favor the highly branched isomers having the highest octane numbers.[2] For example, Figure 1 compares the compositions and octane numbers of typical virgin hexanes with the equilibrium products at 750 F. and 250 F. At high temperature, the product rates approximately 90 octane number; at low temperature, it contains more highly branched isomers and rates about 95.

Isomerization processes can use either high- or low-reaction temperatures. When the higher temperatures are used, fractionation and recycle of product are normally required to achieve desired octane gains. With low-temperature operation, the need for recycling is reduced and in many cases eliminated.

Process Description. The Isomate process is ideally suited to all light naphthas up to approximately 180 F. end point that have been recovered from virgin, catalytically reformed, or catalytically hydrogenated stocks. Octane increase is primarily a result of converting *n*pentane and *n*hexane to *iso*pentane, methylpentanes, and dimethylbutanes. The reactions are catalyzed by a highly selective liquid

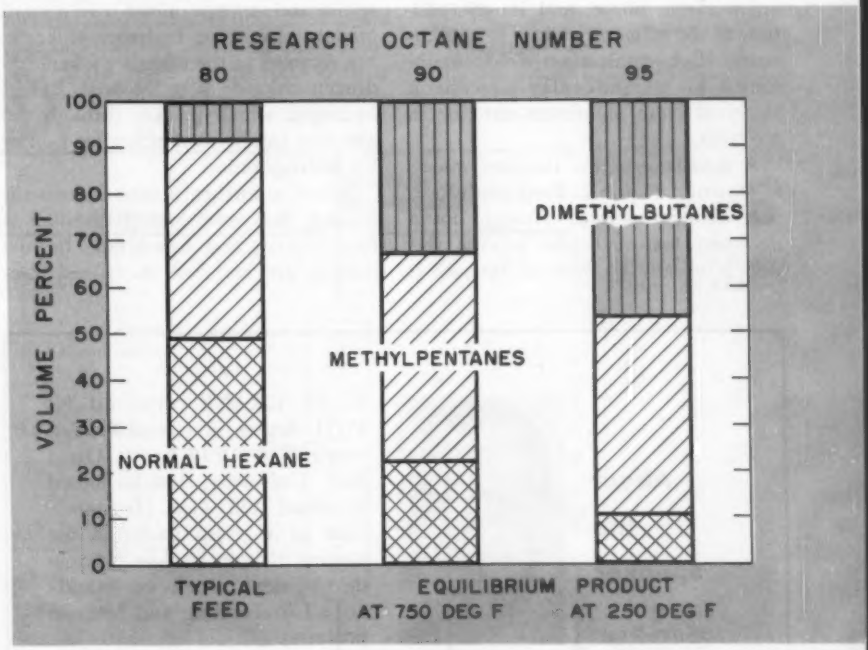


FIGURE 1—Composition and leaded octane number of hexanes: Operation at lower temperature is attractive.

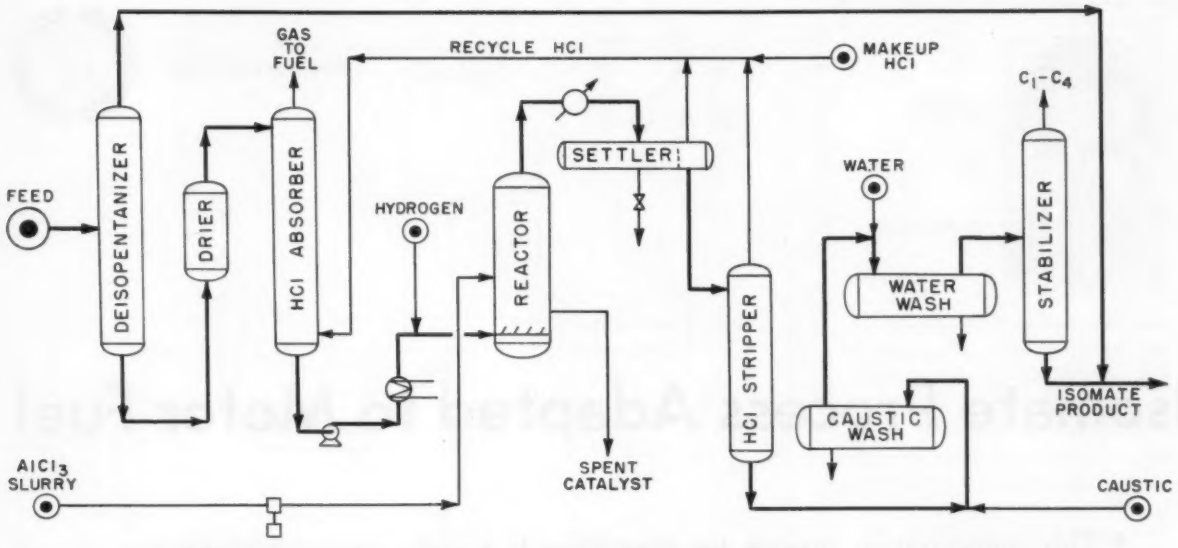


FIGURE 2—Flow scheme for Isomate Process: Deisopentanizing of feed naphtha is usually economical.

complex of aluminum chloride and hydrocarbon; little hydrocarbon cracking takes place.[5,6]

The reaction is carried out in a simple, cement-lined drum, mounted vertically and containing a pool of the liquid catalyst. Naphtha, with dissolved hydrogen chloride to activate the catalyst, is introduced as a liquid at the bottom of the drum. Hydrogen is also introduced to suppress cracking and catalyst contamination. The naphtha rises through the catalyst as an insoluble phase, and its composition in the effluent is close to equilibrium. High catalyst activity is maintained by periodically injecting a slurry of fresh aluminum chloride in naphtha.

A flowsheet of the Isomate process is shown in Figure 2. Feed naphtha is first deisopentanized. Though not a necessary feature of the process, this step is usually economical because it reduces the size of the reaction section and gives more *iso*pentane. The deisopentanized naphtha is dried and sent to an absorber where it picks up hydrogen chloride. It enters the reactor at 200 F. to 250 F. and 700 psi to 850 psi, along with 60 to 100 cubic feet of hydrogen per barrel. Effluent from the reactor is cooled and flashed into a settler for separation of entrained catalyst. The liquid product is stripped of hydrogen chloride and is cooled, washed, and stabilized. Gases from the settler and stripper, along with a small amount of makeup hydrogen chloride, are recycled to the absorber where hydrogen chloride is redissolved. Excess hydrogen which passes through the absorber can be used either for fuel or for hydrogenation.

When a further octane increase is desired, the once-through product is fractionated, and low-octane hexane isomers are recycled. A typical fractionation scheme for recycling hexanes is shown in Figure 3. The stabilized reactor effluent is first fractionated to give a primary overhead product composed of pentanes, neohexant, di*iso*propyl, and some methylpentanes. Low-octane hexane isomers are recycled to the reactors after rerunning to prevent accumulation of heavy ends in the system. The material removed by rerunning is highly naphthenic, rich in cyclohexane and methylcyclopentane.

Still higher octane numbers can be obtained by fractionating and recycling *n*pentane from the overhead product of the primary fractionator. However, because the Isomate process gives approximately 73 percent conversion of *n*pentane to *iso*pentane, recycling *n*pentane raises the product octane number only moderately.

The Isomate Product. The once-through product from the Isomate process is a high-octane light naphtha, ideal as the volatile blending component for premium fuel. The pentane fraction rates approxamately 103 Research octane number, leaded, and the hexane fraction rates about 94. The octane number of the total product depends on the ratio of pentanes to hexanes and normally ranges from 96 to 98.

Table 1 shows how a light naphtha is upgraded by once-through processing. A debutanized product of 97.2 Research octane number, leaded, is obtained with the following yields:

About the Speaker

H. G. KRANE received his Ph.D. degree in chemical engineering in 1953 from Ohio State University, then he joined Standard Oil Co. (Indiana). Now as a group leader in the process division he does process-development work on Standard's Ultraforming and Isomate processes.

	Percent by Volume	Percent by Weight
Debutanized naphtha	97.5	96.7
*Iso*butane	2.0	1.7
*n*Butane	0.7	0.6
Dry gas	...	1.0

TABLE 1

How Once-Through Isomate Upgrades a Light Naphtha

	Feed*	Debutanized Product
ASTM distillation, deg F.:		
Initial boiling point	101	93
10-percent point	112	101
50-percent point	125	116
90-percent point	144	138
End point	152	190
Gravity, deg API	84.4	85.0
Reid vapor pressure, lb	10.8	12.7
ASTM octane number (D 908, Research Method):		
Without TEL addition	71.2	83.8
With addition of 3 ml TEL per gal	89.1	97.2

* 65 percent Mid-Continent virgin; 35 percent from catalytic reformate.

Even higher octane numbers are obtained when low-octane hexanes are recycled. Table 2 shows how recycling approximately 2 volumes of hexanes for every 3 volumes of fresh reactor charge further upgrades the same light naphtha. The total debutanized product has a Research octane number of 101.3, lead. The primary product, composed of overhead from the deisopentanizer and the primary fractionator, has a Research octane number of 101.8, leaded. The yields are:

	Percent by Volume	Percent by Weight
Debutanized naphtha:		
Primary product	93.2	91.4
Naphthenic product	2.8	3.2
*Iso*butane	3.2	2.8
*n*Butane	1.0	0.9
Dry gas	...	1.7

By increasing the amount of hexane recycle and also recycling *n*pentane, a primary product of up to 106 octane number can be obtained.

Typical utilities requirements and processing costs are summarized in Table 3 for the once-through and hexane-recycle operations. Costs for a unit processing 5,000 barrel per day of fresh feed are 25 cents per barrel for once-through operation and 45 cents per bbl when hexanes are recycled. Fuel is valued here at 13 cents per million Btu, and aluminum chloride at 16 cents per pound. With a higher fuel value of 40 cents per million Btu, costs for once-through and recycle operations would be increased to approximately 29 and 58 cents per barrel, respectively. For processing 5,000 barrels per day of fresh feed, a once-through Isomate unit will cost roughly $400 per daily barrel. With hexane recycle and the same fresh-feed rate, it will cost nearly twice as much.

TABLE 2

How Recycle Isomate Upgrades a Light Naphtha

	Feed	Primary Product	Combined Product
ASTM distillation, deg F.:			
Initial boiling point	101	90	90
10-percent point	112	98	98
50-percent point	125	109	110
90-percent point	144	123	127
End point	152	131	225
Gravity, deg API	84.4	87.8	87.0
Reid vapor pressure, lb	10.8	13.8	13.5
ASTM* octane number (D 908, Research Method):			
Without TEL addition	71.2	90.3	89.7
With addition of 3 ml TEL per gal	89.1	101.8	101.3

* Octane numbers above 100 by the Wiese formula,

$$\text{octane number} = 100 + \frac{PN-100}{3}$$

Where Isomate Fits In. As an effective way to upgrade naphtha, the

TABLE 3

Utilities Requirements and Processing Costs for Isomate Process

	Once-Through	Recycle
Feedstock		
Fresh feed, bbl per day*	5,000	5,000
Reactor feed, bbl per day	4,040	6,710
Utilities Requirements		
Process heat, mm Btu per hour	21.9	79.3
Electric power, kw	180	360
Process and cooling water, gal per min	1,900	4,500
Processing Costs, Dollars per Day		
Operating and miscellaneous labor	340	450
Maintenance	260	490
Utilities†	190	620
Chemicals:		
Catalyst	260	430
Other	110	180
Miscellaneous	80	90
Total cost, dollars per day	1,240	2,260
Processing cost, cents per bbl of fresh feed	25	45

* Deisopentanizer feed.

† Fuel value at 13 cents per million Btu. Utilities costs based on steam at 28 cents per million Btu; electric power at 0.5 cents per kwh; and cooling water at 0.8 cents per thousand gal.

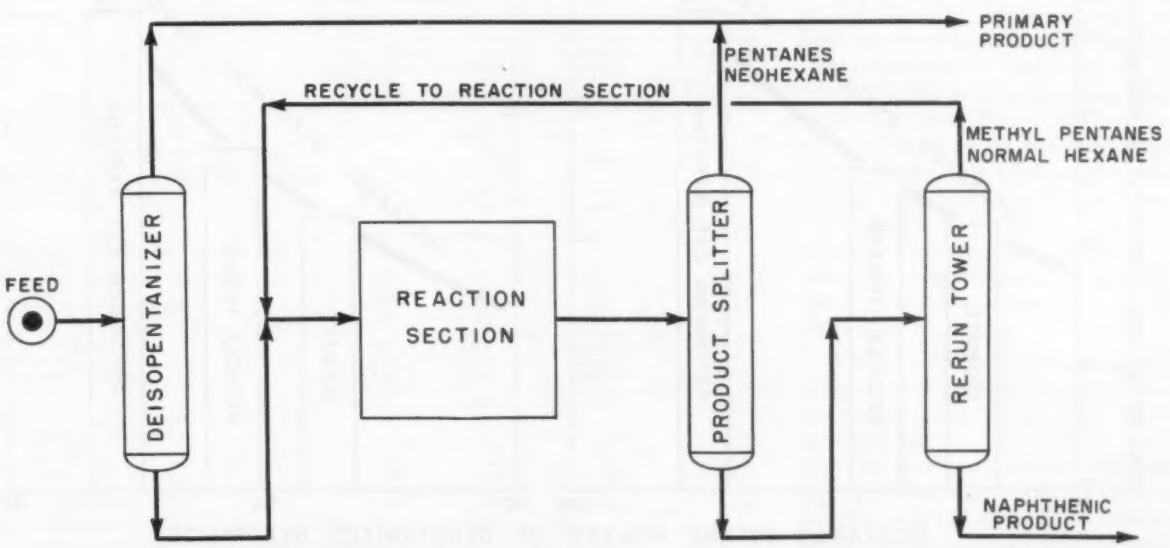


FIGURE 3—Recycle Isomate Process: Low octane hexane isomers are recycled to give further octane increase.

Isomate process provides octane potential above that of catalytic reforming alone. Moreover, it offers an attractive way to minimize the cost of higher octane numbers even before maximum potential is needed. Aside from isomerization, higher octane numbers will be obtained chiefly by reforming heavy virgin and thermal naphthas more severely than now practiced, or by reforming heavy catalytic naphtha. The position of the Isomate process therefore depends upon a comparison of costs with both reforming options.

To illustrate this comparison, a refinery is considered which processes 100,000 barrels of Mid-Continent crude oil per day, with process facilities based on approximate average capacities for domestic refineries. Heavy virgin, thermal, and coker naphthas, averaging 21,000 barrels per day, are reformed to 95 Research octane number, clear. The catalytic-reforming process is assumed to be Ultraforming—one well adapted to meeting future octane needs by high-severity operation.[7,8] Total gasoline production is 40,000 barrels and initially rates about 99 Research octane number, leaded.

Octane ratings can be raised in this refinery by installing Isomate facilities, by Ultraforming the virgin-thermal feed more severely, or by Ultraforming catalytic naphtha in a new unit. Yields and product quality for each option are shown in Table 4. Both the Isomate and Ultraforming facilities are assumed to be on stream 330 days each year. The once-through and recycle Isomate operations are those described in Figures 3 and 4. Pentane-hexane feed amounts to 6,180 barrels per calendar day, of which 2,150 barrels are recovered from light Ultaformate and the rest from virgin naphtha. Prefractionation removes 1180 barrels of *iso*pentane, and deisopentanized feed to the reactor amounts to 5000 barrels per day. More severe reforming of virgin and thermal

TABLE 4

Ways to Raise Octane Number

	ISOMATE		Increased Reforming Severity from 95 to 98 Octane Number	Catalytic Reforming of Heavy Catalytic Naphtha
	Once-Through	Recycle		
Feed				
Type	C_5 to C_6 from light virgin naphtha and reformate		Catalytic reformate*	Heavy catalytic naphtha
Bbl per calendar day	6,180	6,180	17,550	6,000
ASTM† octane number (D 908, Research Method):				
Without TEL addition	71.2	71.2	95.0	90.0
With addition of 3 ml TEL per gal	89.1	89.1	101.3	96.2
Reid vapor pressure, lb	10.8	10.8	3.9	1.5
Yields, Bbl Per Calendar Day				
Dry gas (FOE‡)	50	80	380	470
Butane	170	260	370	560
Debutanized gasoline	6,020	5,930§	16,800	4,960
Properties of Debutanized Product				
ASTM† octane number (D 908, Research Method):				
Without TEL addition	83.8	89.7	98.0	100.0
With addition of 3 ml TEL per gal	97.2	101.3	103.1	104.2
Reid vapor pressure, lb	12.7	13.5	4.6	4.0

* Butane-free portion of reformate at the initial octane number.
‡ A "fuel-oil equivalent" represents 150,000 Btu net heating value per gal.
§ Includes 180 bbl per calendar day of rerun tower bottoms.
† Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN-100}{3}$

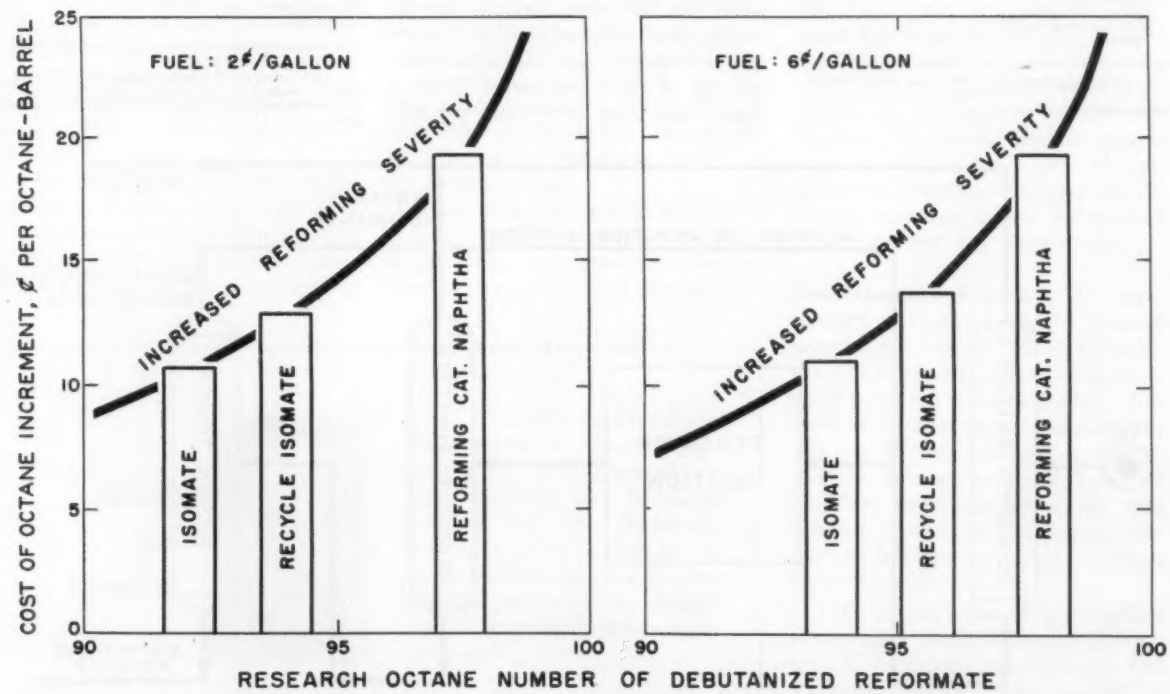


FIGURE 4—How the cost of increasing reforming severity (curve) compares with using Isomate Process and Ultraforming naphtha (vertical bars).

naphthas can be readily accomplished by expanding the existing ultraforming unit. For illustration, the octane number of debutanized reformate is increased from 95 to 98, with a corresponding decrease in yield from 81.5 to 78.0 percent by volume of feed. As the final alternative, a new Ultraformer is installed to process 6000 barrels of catalytically cracked naphtha per day. The feed has a boiling range of 200 F. to 360 F., and is reformed from 90 to 100 octane number.

Costs are compared in Table 5. Because both the Isomate and Ultraforming facilities process the maximum feed available, they increase the octane number of motor fuel by different amounts. Costs are compared, therefore, on the common basis of cents per octane-barrel, representing the average cost of increasing the leaded octane number of 1 barrel of motor fuel by 1 unit. For simplicity, the octane increases shown in Table 5 are based on straightforward octane-barrel calculations and the leaded octane numbers of feed and product. Gasoline loss is made up with 97 octane-number gasoline, valued at 13 cents per gallon; vapor pressure is kept constant by removing butane, valued at 4 cents per gallon. Investment costs are included by amortizing at the rate of 30 percent per year, corresponding to a rate of return of approximately 16 percent on investment after income taxes. Costs of 10.7 cents and 12.9 cents per octane-barrel for once-through and recycle Isomate operations are lower than those for either reforming alternative: 17.9 cents for increasing reforming severity and 19.4 cents for reforming catalytic naphtha. The high yield attained with the Isomate process more than offsets higher investment and processing costs.

If the present octane trends continue, all of the process operations outlined will ultimately be needed. To minimize costs, however, an important consideration is the proper sequence of processing steps. Reforming severity can be increased by varying degrees, in contrast to the single case illustrated; however, costs for successive increments rise rapidly. The curves of Figure 4, for example, relate the cost of increasing reforming severity with the initial octane number of reformate. The vertical bars represent the comparative costs of increasing octane number by the Isomate process and by Ultraforming catalytic naphtha. Once-through Isomate results in lower over-all costs than increasing reforming severity above reformate octane levels of 92 to 94, the exact octane number depending on fuel value. Recycle Isomate operations are more attractive above 94 to 96 octane number. Installation of Isomate facilities in this illustrative refinery is therefore desirable well before the maximum potential of catalytic reforming is employed.

The Isomate process will be even more attractive where catalytic-reforming facilities are of a nonregenerative type. Ultraforming regenerates the platinum catalyst employed and is consequently well suited to high-severity operation. Purchase of catalyst represents almost the entire investment cost needed to raise severity and can be deferred until needed; costs for additional reactor or regeneration capacity are small. For nonregenerative processes, on the other hand, costs to increase reformate octane number might be much higher, and Isomate facilities would become attractive correspondingly sooner.

In addition to raising the average quality of motor fuel, the high-octane Isomate product from recycle operations can raise the maximum octane number to which premium gasoline can be blended. This advantage is illustrated in Table 6 for a premium fuel blended to 10-pound RVP (Reid vapor presure), and 25 percent evaporated at 158 F. When the maxium octane number is desired, as limited by available blending stocks, the principal low-boiling component will be light catalytic naphtha. The ceiling octane number for premium fuel in this case is 102 to 104, the exact value depending upon the octane number of available reformate. However, when recycle Isomate is used as the light component, the ceiling octane number is increased by 2 to 4 units. Extraction of aromatics to provide a heavy component results in approximately the same octane ceilings as 100-octane reforming.

When considering in detail the blending-stock needs for both premium and regular gasolines, light-naphtha isomerization will in many cases be more attractive than described. When light virgin naphtha is isomerized, it will normally be blended into premium gasoline; light catalytic naphtha, the usual volatile compo-

TABLE 5

How Costs Compare

	ISOMATE		Increased Reforming Severity from 95 to 98 Octane Number	Catalytic Reforming of Heavy Catalytic Naphtha
	Once-Through	Recycle		
Total Motor Fuel				
Bbl per calendar day	←	40,000	→	
Increase, Research octane number with addition of 3 ml TEL per gal	1.12	1.66	0.77	1.26
Investment Cost, in Thousands of Dollars				
Process equipment	2,560	4,840	50	2,700
Initial catalyst	30	50	1,260	690
Total investment	2,590	4,890	1,310	3,390
Total Costs, Dollars Per Calendar Day				
Materials:				
Makeup gasoline at 13 cents per gal*	2,100	3,170	5,670	7,760
TEL	—110	—160	— 290	— 390
Butane at 4 cents per gal	—660	—1,000	—1,100	—1,570
Fuel produced at 2.0 cents per FOE† gal	— 40	— 60	— 3.20	— 400
Subtotal	1,290	1,950	3,960	5,400
Processing	1,390	2,580	480	1,600
Investment charge‡	2,130	4,020	1,080	2,790
Total costs	4,810	8,550	5,520	9,790
Cost of Octane Improvement, Cents Per Research Octane-Bbl				
Materials	2.9	2.9	12.9	10.7
Processing	3.1	3.9	1.5	3.2
Investment	4.7	6.1	3.5	5.5
Total costs	10.7	12.9	17.9	19.4

* 97 Research octane number with addition of 3 ml TEL per gal.
† Fuel-oil equivalent.
‡ Investment amortized at 30 percent per year.

nent of premium fuel, will then be shifted to regular. The resulting increase in the average octane number of premium and regular gasolines will be higher than the simple octane-barrel increase shown in Table 5. This bonus can be as much as 0.5 Research octane number in some cases, with a corresponding decrease in the octane-barrel costs for isomerization.

Isomerization will also favorably affect road-octane ratings of gasoline. At a specified Research octane level, road ratings decrease with an increase in spread between Research and Motor ratings. During the past eight years, the average Research rating of motor fuel has increased by more than 9 octane numbers, but the Motor rating has only increased by approximately 7.5. As a result, road ratings have lagged behind increases in Research octane number. Isomerization, however, increases Motor ratings by at least as much as Research ratings. Consequently, an increase in the Research octane number by isomerization will show a greater increase in road performance than was typical in the past.

TABLE 6
Ceiling Octane for Premium Gasoline

	ASTM Research Octane Number With Addition of 3 ml TEL per Gal	
	Reforming to 95 Octane Number, Clear	Reforming to 100 Octane Number, Clear
Premium-Fuel Components		
Heavy reformate	104.5	110.0
Light catalytic naphtha	←——99.3——→	
Recycle Isomate	←——101.8——→	
Premium-Fuel Blend†		
Using light catalytic naphtha	102	104
Using recycle Isomate	104	108

† Includes butane.
* Octane numbers above 100 by the Wiese formula, $\text{octane number} = 100 + \frac{PN-100}{3}$.

Original presentation was before the American Petroleum Institute, Division of Refining, Philadelphia, May 13-16, 1957.

LITERATURE CITED

[1] "How to Check Octane Numbers Above 100," *Oil Gas J.*, 54 [82] 96 (1956).
[2] B. L. Evering and E. L. d'Ouville, "Experimental Equilibrium Constants for the Isomeric Hexanes," *J. Am. Chem. Soc.*, 71 [2] 440 (1949).
[3] J. E. Swearingen, R. D. Geckler, and C. W. Nysewander, "The Isomate Process," *Trans. Am. Inst. Chem. Engrs.*, 42, 573 (1946).
[4] B. L. Evering, N. Fragen, and G. S. Weems, "Light Paraffins—Their Commercial Isomerization," *Chem. Eng. News*, 22 [21] 1898 (1944).
[5] B. L. Evering and R. C. Waugh, "Catalytic Isomerization of Isomeric Hexanes," *Ind. Eng. Chem.*, 43 [8] 1820-1823 (1951).
Chem.,
[6] B. L. Evering, E. L. d'Ouville, A. P. Lien, and R. C. Waugh, "Isomerization of Pentanes and Hexanes—Nature and Control of Side Reactions." *Ind. Eng. Chem.* 45 [3] 582-589 (1953).
[7] J. H. Forrester, A. L. Conn, and J. B. Malloy. "Ultraforming—New Reforming Process," *Petroleum Refiner* 33 [4] 153-6 (1954).
[8] R. A. Steel, J. A. Bock, W. R. Hertwig, and L. W. Russum. "Factors in Selecting a Catalytic Reforming Process," *Petroleum Engr.* 27 [2] C-25 to C-36 (1955); *Proc. API* 34 [III] 327-336 (1954).

More About Isomerization

Iso-Kel. This isomerization process developed by The M. W. Kellogg Company upgrades pentanes and hexanes present in light naphtha and natural gasoline or produced from other processing operations such as reforming and cracking. The process employs a precious metal catalyst (non-platinum) which has been specifically prepared to give long life without regeneration and high isomerization activity with negligible cracking side reactions. The catalyst is used under hydrogen pressure. The high catalyst activity permits operating at temperatures considerably below those normally employed in conventional heavy naphtha reforming operations. The high selectivity of the catalyst is demonstrated by a gas production of less than 1 percent at 60 percent conversion per pass of *n*pentane to *iso*pentane.

In the processing of mixed pentanes and hexanes a single reactor is employed. The amount of accessory fractionation equipment required depends on the composition of the feed stock as well as the quality of the product desired. Recycling of the unconverted *n*pentane and once-through isomerization of the hexane fraction is usually recommended for mixed feeds. This scheme of processing produces an *iso*pentane fraction with an octane of 105.7 with 3 ml TEL (Wiese Scale) and an *iso*hexane rich fraction with an octane of about 91 with 3 ml TEL. The over-all processing of typical feed stocks results in yields of 98 to 99 percent and octane numbers of 95 to 100 with 3 ml TEL.

The investment costs of a 3000 barrel-per-day unit will range from $400 to $500 per barrel, depending on the amount of fractionating equipment employed. Operating costs range from 16 to 24 cents per barrel, including catalyst costs.

("The Iso-Kel Process," E. F. Schwarzenbek, The M. W. Kellogg Company, Jersey City, N. J.)

Penex: The UOP Penex Process uses a new platinum-containing solid catalyst to convert the pentane-hexane fraction to high octane number blending components in an economically attractive hydroisomerization process.

Development of the process was based upon three critical factors: the catalyst must possess high activity; the process should operate at high efficiency; and long catalyst life should be obtained for maximum economy of process operation. Research on the process was further aimed at using the unique nature of the hydroisomerization reaction to obtain optimum values for these factors.

Extensive bench scale studies and pilot plant operations have shown that these desired goals have been achieved in the process. The process achieves nearly equilibrium conversion per pass at high feed rates. Furthermore, even at this high conversion level, liquid yields of 99 percent by volume of *iso*pentane are obtained, indicating nearly perfect process efficiency. Finally, process studies indicate that a catalyst life of above 200 barrels of feed per pound of catalyst can be expected.

Present plant designs for pentane fractions are generally aimed at producing essentially pure *iso*pentane. This product—possessing a 105 leaded Research octane number—is a blending component suitable for use even in the so-called "super premium" gasolines. On the other hand, the UOP Penex Process for hexane fractions is designed with considerable flexibility to meet the needs of individual refinery situations. The latter process can be operated to yield product streams of from 95 to well above 100 leaded Research octane number quality, depending on the extent and complexity of the fractionation and recycle facilities which are provided.

Commercial acceptance of the process is indicated by the fact that several units are in design or construction, covering a wide range of capacities.

("Hydroisomerization by the Penex Process," D. H. Belden and V. Haensel, Universal Oil Products Company, Des Plaines, Ill.; W. C. Starnes and R. C. Zabor, Gulf Research and Development Company, Pittsburgh.)

Upgrading Pentanes with Catalytic Dehydrogenation

• This process can produce higher octane ratings than those possible by isomerization.

• For octane ratings up to isopentane, yields are less than isomerization.

Harold Shalit, F. W. Kirsch, W. S. Briggs and J. B. Maerker
Houdry Process Corporation,
Marcus Hook, Penn.

CATALYTIC DEHYDROGENATION of virgin C_5 fractions is a method of increasing the octane number of such fractions. The results of a preliminary process study of pentane dehydrogenation over a Houdry chromia-alumina catalyst are reported here.

Several pentane mixtures were studied in order to determine the interrelation of yield, octane, and charge composition. Substantial octane improvements were obtained, with good yields; e.g., the octane number of *iso*pentane was increased from 92.3 to 99 Research octane number, clear, with a C_5+ yield of 97 percent. The higher the charge *iso*pentane content, the higher the octane number at any particular yield and, conversely, the larger the yield at any octane number.

Thermal dehydrogenation produced much poorer liquid yields than did catalytic dehydrogenation. Pentane isomerization gave somewhat better yields of product, up to the octane level of pure *iso*pentane; however, catalytic dehydrogenation is more flexible in that a greater range of pentane charge compositions can be used, up to *iso*pentane itself, and a higher octane ceiling is obtainable.

Among the various combinations of dehydrogenation and isomerization considered, a most interesting one is isomerization to equilibrium, followed by dehydrogenation of the equilibrium mixture.

Data from Pilot Unit. The catalytic dehydrogenation data reported were obtained from a fixed-bed isothermal pilot unit. The catalyst used was a Houdry chromia-alumina dehydrogenation catalyst. Charge stocks used were technical-grade *n*pentane, pure-grade *iso*pentane, and mixtures of these compounds.

The experimental dehydrogenation data were obtained from a series of atmospheric-pressure runs in which space rate, temperature, and on-stream time were varied over a relatively wide range. Feed-stock composition was varied, as follows:

	Percent by Weight			
*n*Pentane	96	61	40	0
*Iso*pentane	4	39	60	100

The charge stock containing 60 percent of *iso*pentane approximates the equilibrium iso-normal composition at 800 F. to 900 F., and the charge with 39 percent of *iso*pentane represents a typical composition found in natural gasoline. Approximately half of the experiments were single-cycle runs. When larger amounts of product were required, cyclic operation was used. However, optimum cycle time and onstream time were not determined.

Yield-octane-number relationships obtained for catalytic pentane dehydrogenation are presented in Figure 1. These curves are drawn from experiments at all of the space rates and temperatures investigated. All the data show excellent yields at octane ratings substantially higher than the unprocessed charge. By dehydrogenation, *n*pentane with a 63.5 Research octane number, clear, is upgraded to an 85 octane rating, at a 94-percent yield. *Iso*pentane is upgraded from 92.3 to 99 Research octane number, clear, with a 97-percent yield. The octane attainable at any yield in-

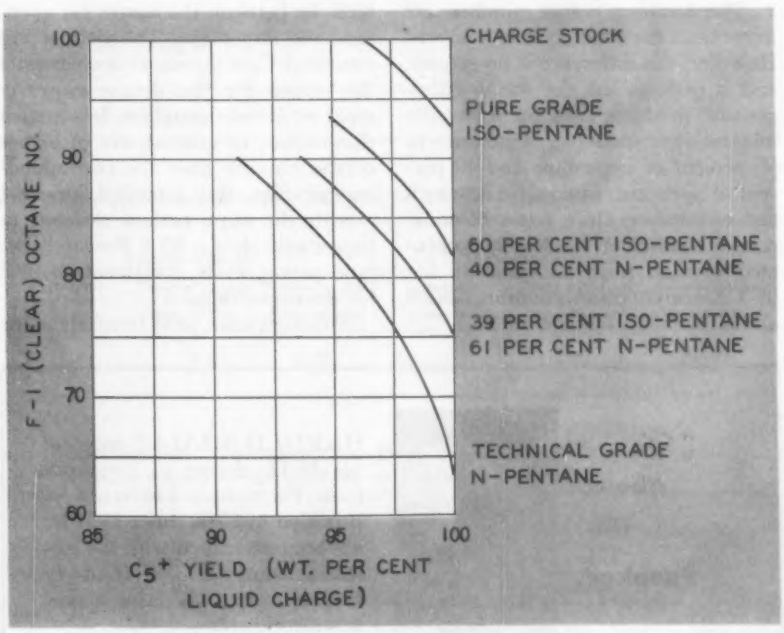


FIGURE 1—Yield-octane curves for pentane dehydrogenation: Octane attained at any given yield increases as isopentane content of charge increases.

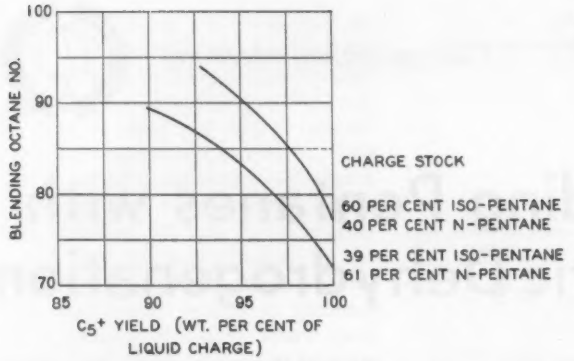


FIGURE 2—Yield-blending curves for dehydrogenation of pentane mixtures (with blends of 20 percent by volume in a typical refinery gasoline pool).

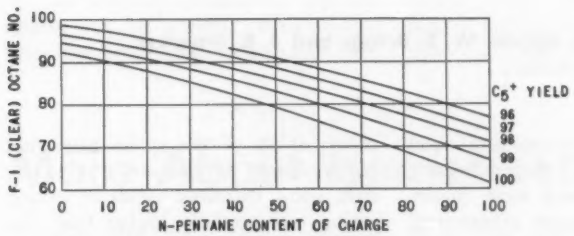


FIGURE 4—Composition-octane-yield correlation for pentane dehydrogenation: As isopentane content increases in charge, higher octane levels are reached.

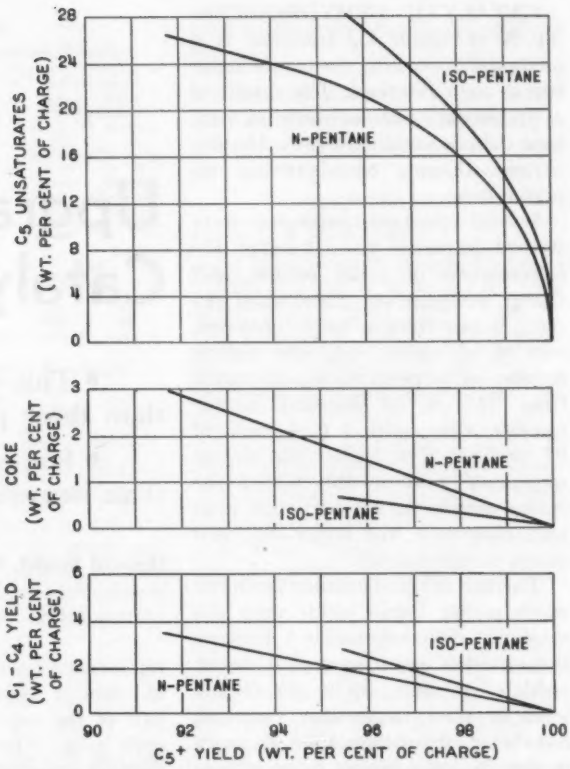


FIGURE 3—Product distribution for pentane dehydrogenation: Yield of C_5 unsaturates is the reason for octane improvement. (Olefins are of higher octane than corresponding paraffins.)

creases as the *iso*pentane content of the charge increases.

Yield-blending-octane-number relationships for the two mixed pentane charge stocks are presented in Figure 2. The blending octane numbers are lower than the actual octane numbers. However, this difference is no greater, and is perhaps less, for the dehydrogenated products than for a paraffin mixture. For example, a mixture of 60 percent of *iso*pentane and 40 percent of *n*pentane, with an 82 Research octane number, clear, has a blending octane number of 77. A dehydrogenated product from this mixture has 93.5 Research octane number, clear, and a blending number of 90.5.

Figure 3 presents product distribution and C_5 unsaturate yields as a function of the C_5 yield for both *n*pentane and *iso*pentane dehydrogenation. The yields for mixed pentane feeds lie between the curves for *n*pentane and *iso*pentane. The yield of unsaturated C_5 compounds demonstrates the reason for the octane improvement by dehydrogenation. It is known that olefins, in general, are of higher octane number than the corresponding paraffins; thus 2-methyl, butene-2—with the same carbon skeleton as *iso*pentane—has a 99.1 Research octane rating, clear, compared to 92.3 for the *iso*paraffin.

Although coke yield from *n*pentane is higher than that from *iso*pentane, the coke yields obtained are within the operable range for commercial adiabatic operation. Slightly higher gas yields are obtained from *iso*pentane dehydrogenation than from *n*pentane dehydrogenation.

A limited number of thermal reforming runs were made in the same equipment used for the catalytic studies. In these instances the reactor was packed with quartz instead of catalyst. The charge used was 37 percent of *n*pentane and 63 percent of *iso*pentane. Results are presented in Table 1. Total pressure was 800 pounds per square inch gage, and oil partial pressure and contact time were varied by charging nitrogen with the pentanes. It is apparent that high octane ratings can be obtained, but C_5+ yields are low. For example, at 1050 F. a 96.9 Research octane number, clear, was obtained, but the C_5+ yield was only 55.9 percent by weight.

Results Foresee Later Impact. The results demonstrate that catalytic dehydrogenation is a potential process to improve the octane rating of pentanes for use in motor gasoline. Inasmuch as the octane obtainable is

About the Speaker

HAROLD SHALIT received his Ph.D. degree in chemistry from Polytechnic Institute of Brooklyn in 1948. Since 1951 he has been associated with the Research department of Houdry Process Corp., where he is now a project director.

higher than that by methods currently being considered, and yields are excellent, the process will become even more important as octane requirements increase.

The typical refinery will have available a mixture of pentane isomers. Consequently, the catalytic dehydrogenation data have been cross-plotted to show yields and octane ratings as a function of feed-stock composition. This correlation is presented in Figure 4. It is clear that as the *iso*pentane content of the charge is increased, higher octane levels can be reached, or higher yields can be reached at a constant octane rating.

During the catalytic dehydrogenation studies, it was found that small amounts of C_5 diolefins were produced. Because the yields of diolefins was low—1 to 5 percent of the dehydrogenation charge—the diolefins are not expected to affect the gum-forming tendencies of the final gasoline pool in a detrimental fashion.

The octane ceilings which can be obtained by thermal reforming and catalytic dehydrogenation of C_5 fractions are similar. However, catalytic dehydrogenation provides substantial yield advantages over thermal reforming, as shown in Table 2. At essentially the same octane rating, the yield from catalytic dehydrogenation is almost 30 percent by weight of charge greater than that from thermal reforming.

Catalytic isomerization of C_5's is limited to a Research octane rating, clear, of approximately 84 for the equilibrium product if no pentane-isomer distillation facilities are used. With precise fractionation, *iso*pentane can be separated from the product and *n*pentane recycled, to provide *iso*pentane product with a 92.3 Research octane rating, clear, at a reported yield of approximately 98 percent. As shown before, results of catalytic dehydrogenation depend on the charge composition, but, in general, higher octane numbers can be realized than with isomerization at only a moderate sacrifice in C_5+ yield. This comparison is shown in Table 3.

Various combinations of dehydrogenation, isomerization, and distillation can produce products with octane numbers higher than those tabulated in Table 3. Results obtainable by several of these combinations are presented in Table 4. These data further show the advantages of dehydrogenating material with the highest possible iso-content. Octane ratings even higher than the 93.5 and 99.0 shown for the combination schemes can be obtained, with small additional yield sacrifices.

Original presentation was before the American Petroleum Institute, Division of Refining, Philadelphia, May 13-16, 1957. ##

TABLE 1

Thermal Reforming of Pentanes

Total Pressure: 800 psig
Charge Stock: 37 percent of *n*pentane, 63 percent of *iso*pentane

	Run No. 1	Run No. 2	Run No. 3
Temperature, deg F	1,000	1,000	1,050
Contact time, min	6.3	8.5	8.2
Oil partial pressure, psi	369	497	493
ASTM octane number (D 908, Research Method), without TEL addition	94.2	95.1	96.9
Yield, percent by Weight of Oil Charge:			
C_5	67.7	62.6	55.9
C_4	13.0	16.4	17.1
C_3	7.3	12.2	12.1
$C_1 + C_2$	11.5	8.5	14.6
H_2	0.2	0.0	0.0
Carbon	0.3	0.3	0.3

TABLE 2

Comparison of Catalytic Dehydrogenation and Thermal Reforming

	Catalytic Dehydrogenation	Thermal Reforming
Charge, Percent by Weight:		
*n*pentane	40	37
*iso*pentane	60	63
ASTM octane number (D 908, Research Method), without TEL addition	93.5	94.2
C_5 + yield, percent by weight	95.0	67.7

TABLE 3—Comparison of *n*Pentane-*Isopentane* Charges in Three Processes

Charge (Research Octane Number, Clear):	*n*Pentane (63.5)			61 Percent of *n*Pentane 39 Percent of *iso*Pentane (75)		
	Catalytic Dehydrogenation	Isomerization Without Distillation	Isomerization With Distillation	Catalytic Dehydrogenation	Isomerization Without Distillation	Isomerization With Distillation
Product, ASTM octane number (D 908, Research Method), without TEL addition	94	84.5	92.3†	94	84.5	92.3†
C_5 + yield, percent by weight	89	98*	98*	91	98*	98*

* Assumed value. † Pure *iso*pentane.

TABLE 4—Typical Results from Combination Isomerization-Dehydogenation Processing

Feed: 61 Percent of *n*pentane, 39 Percent of *iso*pentane, with a 75 Research Octane Number, Clear

	Catalytic Dehydrogenation	Isomerization Without Distillation	Isomerization With Distillation	Isomerization Without Distillation + Catalytic Dehydrogenation	Isomerization + Distillation + Catalytic Dehydrogenation
ASTM octane number (D 908, Research Method), without TEL addition	94	84.5	92.3†	93.5	99.0
C_5 + yield, percent by weight	91	98*	98*	93‡	95‡

* Assumed. † Pure *iso*pentane. ‡ Calculated, based on assumed isomerization yield and known yield from dehydrogenation yield-octane curves.

Upgrading Saturates with Dehydro-Reforming

This process can be used to upgrade C_6-C_8 saturates from BTX production and also light reformate from catalytic reformers.

C. K. Donnell, A. Schneider and D. H. Stevenson
Houdry Process Corporation,
Marcus Hook, Penn.

DEHYDROGENATIVE reforming has been shown to be an effective means for upgrading low-boiling saturate fractions to high-octane products. Use of a rugged chromia-alumina catalyst in a cyclic process at close to atmospheric pressure results in debutanized yields of 80 percent of 95 Research octane number with the addition of 3 ml TEL per gallon reformate from 57.8 Research octane number, clear C_6 to C_7 saturates. Little change in vapor pressure and production of C_3 and C_4 olefins permits potential yields of 10-lb RVP gasoline to be approximately 15 percent by volume greater than the debutanized yield. Other light fractions including the C_8 fraction can be handled readily by the same technique.

Pool Problem. As higher octane levels are reached, blending components which are valuable at lower levels become limiting factors in the refinery gasoline pool. The current problem in this respect occurs in the lower boiling fractions available to the refiner. Isomerization of pentanes and hexanes has been proposed as one means of solving this quality problem. However, this method is limited in antiknock potential, because of the complexity of the hexane fraction and the resulting fractionation problem. There are also other low-boiling, low-quality fractions available which are not readily improved by isomerization, e.g., the C_6 to C_8 saturates remaining from the manufacture of benzene, toluene, and xylenes and the C_6 to C_8 fraction from catalytic reforming of heavy naphtha.

Other structural changes which can result in considerable antiknock improvement for the low-boiling paraffins are conversion to olefins or to aromatics. Conventional catalytic reforming can not accomplish this readily at the pressures required for operation of the platinum-type catalysts. However, low pressure reforming with a suitable catalyst has been found to be capable of these conversions.

Process Conditions. The data reported herein were obtained from bench-scale (300-ml catalyst) units at Sun Oil Company laboratories and a larger scale (10 liters catalyst) pilot unit at the laboratories of Houdry Process Corporation. Three charge stocks were dehydrogenatively reformed over chromia-alumina catalyst at pressures near atmospheric, with and without hydrogen recycle. Because of the quantity of coke deposited on the catalyst, the process must of necessity be operated with periodic regeneration. The length of the onstream period permitted between regenerations will vary with severity level. Cycle length as a variable has shown no particular effect on catalytic activity or selectivity over the range of onstream periods studied.

Bench-Scale Studies. Exploratory runs were made in fixed-bed units containing approximately 300 ml of catalyst. Typical results are shown in Table 1.

The feed used for most of the ex-

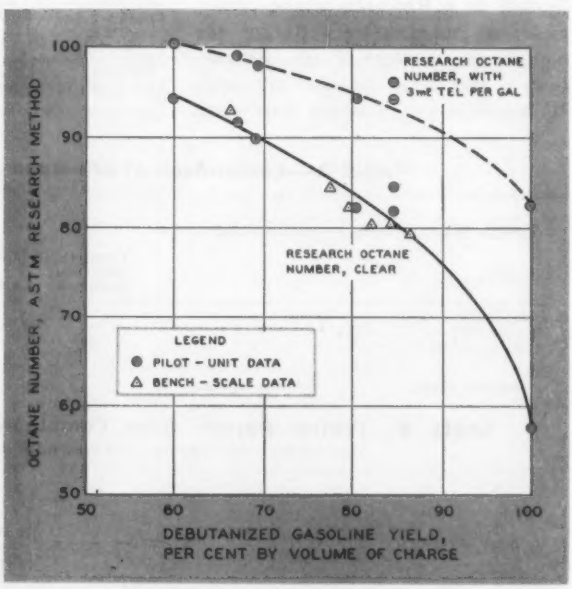


FIGURE 1—Yield octane curve for dehydrogenative reforming (of raffinate from benzene-toluene production): Both pilot unit and bench-scale data are in excellent agreement.

ploratory work was a C_6 to C_7 saturate fraction from benzene-toluene manufacture. Without hydrogen recycle, coke and gas yields were relatively high (Table 1, Example I).

Hydrogen recycle suppressed coke and gas formation extensively and the liquid recovery was increased correspondingly. With hydrogen recycle (Table 1, Example II) the coke yield was reduced from 7.5 percent by weight of the feed to only 1.4 percent at approximately the same octane level. Inasmuch as the addition of hydrogen reduces residence time over the catalyst with all other conditions equal, severity must be increased to maintain octane when hydrogen is used.

Example III (Table 1) illustrates results obtained with the C_8 saturates remaining from xylene manufacture. Although the octane rating of this feed was 8.0 octane numbers lower than that of the benzene-toluene raffinate, it could be upgraded more easily. The yield, 85.9 percent by volume of C_5+ at 87.1 Research octane number, clear, was appreciably better than that from the C_6 to C_7 fraction. The product contained 49.0 percent by volume of aromatics, showing that extensive dehydrocyclization of paraffins occurred. It runs at more severe conditions, products with 97 Research octane number, clear, were obtained with aromatic contents as high as 65 percent by volume.

Example IV (Table 1) shows results obtained with the 140-F. to 250-F. fraction from a catalytic reformate prepared by reforming a 260-F. to 375-F. straight-run naphtha over a platinum-containing catalyst. This low-boiling fraction consisted almost exclusively of isomeric hexanes, heptanes, and octanes produced by hydrocracking from higher boiling components of the feed.

A product with 91.7 Research octane number, clear, was obtained in 78.3 percent by volume yield. This product contained 40.0 percent aromatics and 14.0 percent olefins. At the severity required to yield this octane, the gas make was relatively high, 14.9 percent by weight of the feed, but only 1.0 percent of the feed was converted to coke.

Pilot-Unit Studies. A more extensive investigation of dehydrogenative reforming was carried out in a heat-balanced fixed-bed pilot unit of 10-liter catalyst volume. A C_6 to C_7 saturate fraction (raffinate) from benzene-toluene production was upgraded from 57.8 to the range of 80 to 95 Research octane number clear. Figure 1 presents the yield-octane curve obtained from this study. Both pilot-unit and bench-scale data are shown in excellent agreement. At 95 Research octane number with the ad-

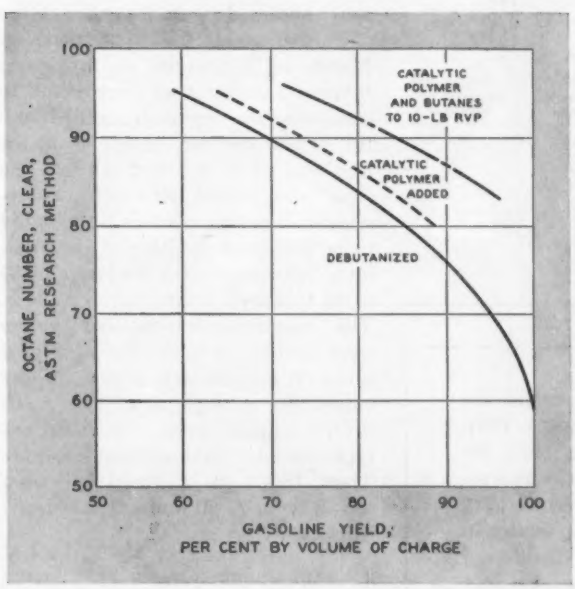


FIGURE 2—Yield-octane curve when catalytic polymerization is added to dehydrogenative reforming (of raffinate from benzene-toluene production): Potential yield of 10-lb. RVP is also high.

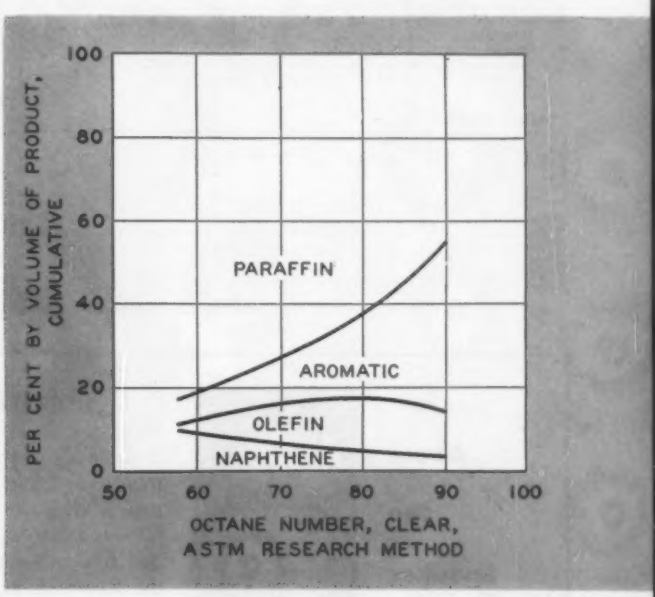


FIGURE 3—Properties of gasoline produced by dehydrogenative reforming (of raffinate from benzene-toluene production): A big part of octane improvement is due to conversion of paraffins to aromatics.

dition of 3 ml TEL per gallon, a debutanized product yield of 80 percent by volume is obtained. A complete typical product distribution for this type operation is given in Table 2.

The product distribution shown in Table 2 suggests the possibility of recovery of butylenes and propylene and subsequent catalytic polymerization. Yields and octanes have been calculated for the inclusion of potential catalytic polymer gasoline in the dehydrogenatively reformed gasoline. The resulting yield-octane curve is shown in Figure 2. Also shown is the potential yield of 10-lb Reid vapor pressure (RVP) gasoline. Because little change in volatility of the charge occurs (on a C_5+ basis), the yields of 10-lb RVP gasoline are excellent.

TABLE 1
Dehydrogenative Reforming of Paraffinic Feeds

	I	II	III	IV
	C_6 to C_8 Saturates*		C_8 Saturates†	Light Reformate‡
Feed:				
Properties of Feed				
ASTM octane number (D 908, Research Method):				
Without TEL addition	60.7		52.7	64.8
Blending value, octane number§	64.9		....	65.8
Gravity, deg API	69.5		56.2	66.0
ASTM distillation, deg F:				
10-percent point	168.0		230.0	....
50-percent point	180.0		234.0	....
90-percent point	206.0		244.0	....
Aromatics, percent	8.0		22.0	....
Olefins, percent	2.0		2.0	....
Naphthenes, percent	12.0		14.0	....
Paraffins, percent	78.0		62.0	....
Hydrogen recycle	No	Yes	Yes	Yes
Products:				
C_5+ liquid, percent by volume	71.8	82.5	85.9	78.3
Gas, C_4-, percent by weight	17.0	11.1	9.0	14.9
Coke, percent by weight	7.5	1.4	0.7	1.0
Properties of C_5+ liquid product				
ASTM octane number (D 908, Research Merthod):				
Without TEL addition	....	86.2	87.1	91.7
Blending value, octane number§	88.5	85.6	....	90.8
Aromatics, percent	....	30.0	49.0	40.0
Olefins, percent	....	16.0	9.0	14.0
Naphthenes, percent	....	4.0	2.0	2.0
Paraffins, percent	....	50.0	40.0	44.0
Gravity, deg API	60.2	59.9	47.2	56.5

* Raffinate from benzene-toluene production.
† Paraffinic distillate from xylene production.
‡ 140-F to 250-F fraction from reforming 260-F to 375-F straight-run.
§ Blending value octane number, ASTM Research Method, in typical refinery pool gasoline.

TABLE 2
Typical Pilot-Plant Data—Dehydrogenative Reforming C_6 to C_7 Saturate Fraction

Inspections	Charge	Product	
Gravity, deg API	72.0	65.1	
ASTM distillation, deg F:			
10-percent point	171.0	160.0	
50-percent point	185.0	187.0	
90-percent point	222.0	230.0	
Reid vapor pressure, lb	....	4.4	
ASTM octane number (D 908, Research Method):			
Without TEL addition	57.8	81.6	
With addition of 3 ml TEL per gal	82.3	94.5	
Composition, percent C_5 + by volume:			
Paraffins	83	61	
Olefins	2	17	
Naphthenes	9	5	
Aromatics	6	17	
Product Yields		Percent by Weight	Percent by Volume
C_5 + liquid		87.5	84.5
Ethane		2.7	...
Butylenes		2.4	2.8
*n*Butane		2.2	2.7
Propane		1.7	...
Methane		1.1	...
*Iso*butane		0.9	1.1
Hydrogen		0.8	...
Propene		0.2	...
Ethene		0.1	...
Coke		0.4	...

About the Speaker

C. K. DONNELL received his M.S. degree in chemistry from Temple University in 1941. He then joined Sun Oil Co. as a research chemist, where in 1952 he was made a group leader in the Basic Research division of the Research and Development department.

Properties of Products. Some of the properties of the gasolines produced by dehydrogenative reforming have been studied in detail. The compositions of these gasolines indicate that a large portion of the octane improvement has been gained by conversion of paraffins to aromatics. This is illustrated in Figure 3 where chemical composition is shown as a function of octane rating. These data were obtained with the C_6 to C_7 saturate fraction from benzene-toluene production. Olefins also contribute to the octane improvement of this material as shown in Figure 3. However, the olefin content does not go above approximately 17 percent by volume. Only a minor fraction of the olefins are diolefin type. The quantity is such that gum forming tendencies have not been observed.

Inasmuch as olefins and aromatics are the chief products of dehydrogenative reforming, blending octanes were obtained as a measure of the performance of this type product. Blends of 20 percent in a typical refinery gasoline pool were made to determine the research method and the motor method blending octane numbers, clear and leaded. Both the clear and leaded Research octane-number blending octanes were found to be the same as those of the undiluted reformates over the range of 80 to 93 Research octane number, clear. The motor octane-number values were found to have the expected spread from Research octane-number values. For example, at a 92 Research octane number, clear, the motor octane-number blending value was 83.0. Thus, this type material has been shown to have no unusual characteristics.

Original presentation was before the American Petroleum Institute, Division of Refining, Philadelphia, May 13-16, 1957. ##

How Humble Runs Catalytic Reformers

- **Successful regeneration techniques give platinum catalyst life of two years.**
- **Major problems of sulfur and hydrogen sulfide corrosion have been solved.**

H. C. Nix
Humble Oil & Refining Company,
Baytown, Texas

IN JUNE 1955 the Humble Oil & Refining Company installed a new 20,000-barrel-per-stream-day reformer using a platinum-on-alumina catalyst developed by Standard Oil Company (Indiana). In August of the same year, Humble's older molybdena reformer was converted for the use of the same platinum catalyst, also at a design charge rate of 20,000 barrels per stream day. The process design of these units was done by Humble.

The reformers charge three narrow-cut fractions produced from a mixture of naphthas boiling from 200 F. to 370 F. These feeds are normally reformed to produce reformate of approximately 93 Research octane

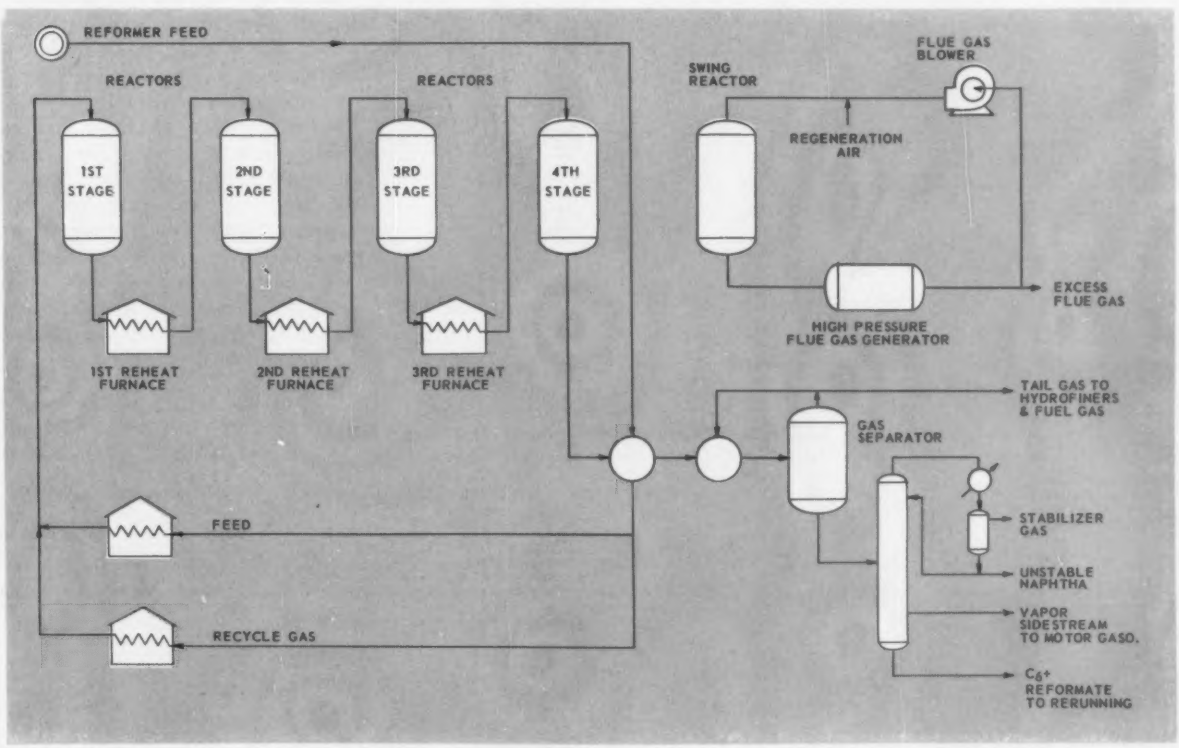


FIGURE 1—Flow scheme for Humble's two reformer units: Regeneration feature makes low-pressure operations possible.

number, clear, although reformate of 100 Research octane number, clear, has been produced. The major problems have been sulfur and hydrogen sulfide corrosion and scale. Facilities to eliminate these difficulties will be installed shortly. Successful regeneration techniques have been developed which have maintained high catalyst activity. Catalyst life is now expected to be approximately two years.

Process Description. The two units can best be described as fixed-bed, regenerative catalytic reformers utilizing a platinum-on-alumina catalyst. The oil flow is simple as shown in Figure 1.

The regenerative feature of the catalyst helps to make possible the following range of operating conditions:

1. Feed rate, bbl per stream day...20,000
2. Recycle-gas ratio, std cu ft per barrel of fresh feed.....3500 to 6000
3. Average reactor pressure, psig .....200 to 325
4. Reactor inlet temperature, deg F. .....840 to 960
5. Design product Research octane number, clear.....93
6. Ultimate product Research octane number, clear.....100+

Feed preparation: The reformer feed-preparation facilities are located at a separate unit. The virgin-naphtha pipe-still fraction from a mixture of Texas crude oils is, at present, partly desulfurized to approximately 100 parts per million of sulfur. It is then fractionated into three successive narrow cuts, boiling in the range from 200 F. to 370 F. The lightest of these feeds, boiling from 200 F. to a final boiling point of 270 F., is charged preferentially to the converted hydroformer, which has a pressure limitation of approximately 250 pounds per square inch gage. The other two feeds, boiling from 260 F. to 310 F. and 300 F. to 370 F., are charged in blocked operations to the new reformer. This unit is capable of operating at approximately 325 psig. It is planned to install a hydrodesulfurization unit which will reduce the feed sulfur level to less than 25 ppm.

Product recovery: The product-recovery system used in Humble Oil & Refining Company's platinum reformers consists of a depentanizer which stabilizes the liquid product from the high-pressure separator. The unique feature of the depentanizing towers is that they are equipped to produce a vapor side stream at about three trays above the tower bottom. When it is desired to produce a stabilized reformate suitable for direct motor-gasoline blending, a side-stream cut is produced. Approximately 80 percent of the 430F.+ polymer material which is normally in the reactor product is removed when the reformate is produced as a vapor side stream. Normally, most of the reformate from the company's reformers is fractionated in other units for production of aromatic solvents and blend components of aviation as well as motor gasoline. Complete polymer removal is accomplished in this operation.

Special Safety Controls. To prevent the hazard of mixing regeneration gases and hydrocarbon vapors, the reactors are provided with double block valves and a seal-gas system. When a reactor is on reaction, the regeneration valves are closed and an elevated pressure maintained between the valves with an inert seal gas. When a reactor is being regenerated, its hydrocarbon valves are closed in the same way. The seal-gas system is provided with flow, pressure, and temperature recorders and alarms. The double valve system is of supreme importance as it makes possible blinding off one reactor from service, for repairs or catalyst change,

TABLE 1
Platinum-Reformer Feed Inspections

	200 to 270	260 to 310	300 to 370
Feed nominal boiling range, deg F.			
ASTM distillation, deg F;			
Initial boiling point	210	272	306
5-percent point	213	275	310
10-percent point	216	277	312
20-percent point	218	279	314
30-percent point	220	280	316
40-percent point	222	281	318
50-percent point	224	282	321
60-percent point	228	283	324
70-percent point	232	285	328
80-percent point	236	287	333
90-percent point	245	290	341
95-percent point	253	295	349
Final boiling point	278	318	371
Gravity, deg API	56.9	51.6	47.3
Hydrocarbon type, percent by volume;			
Aromatics	10	16	19
Paraffins	42	41	39
Naphthenes	48	43	42
Olefins	0	0	0
Sulfur, ppm	72	105	125
ASTM octane number (D 908, Research Method);			
Without TEL addition	61.5	54.0	53.0
With addition of 3 ml TEL per gal	80.4	73.6	72.9
ASTM octane number (D 357, Motor Method);			
Without TEL addition	60.0	52.7	53.2
With addition of 3 ml TEL per gal	80.0	72.9	72.9

TABLE 2—Platinum-Reformer Product Yields

Feed nominal boiling range, deg F.	200 to 270				260 to 310				300 to 370			
C_5+ product octane number...	93 YIELD		97 YIELD		93 YIELD		97 YIELD		90 YIELD		93 YIELD	
	Percent By Volume	Percent By Weight	Percent By Volume	Percent By Weight	Percent By Volume	Percent By Weight	Percent By Volume	Percent By Weight	Percent By Volume	Percent By Weight	Percent By Volume	Percent By Weight
Product;												
H_2	....	2.3	....	2.5	....	1.9	....	2.0	....	1.5	....	1.7
C_1	....	0.6	....	1.0	....	0.6	....	0.9	....	0.3	....	0.4
C_2	....	1.3	....	2.1	....	1.2	....	2.0	....	0.6	....	0.9
C_3	....	2.5	....	4.0	....	2.3	....	3.7	....	1.1	....	1.7
C_4	5.0	3.8	8.0	6.1	4.6	3.5	7.5	5.6	2.3	1.7	3.5	2.6
C_5	5.0	4.2	8.0	6.7	4.6	3.7	7.5	6.1	2.3	1.8	3.5	2.8
C_5+	80.8	85.3	73.4	77.6	82.0	86.8	74.7	79.7	88.4	93.0	84.9	89.9
	....	100.0	....	100.0	....	100.0	....	100.0	....	100.0	....	100.0

without affecting the rest of the unit.

The hydrocarbon valves for each reactor are motor-operated and push-button-controlled from the control room. One of the regeneration valves is motor-operated and the other is hand-operated. These valves are interlocked electrically to prevent errors in the sequence of valve operation. Oxygen recorders are on the inlet and outlet regeneration gas stream, and each reactor is provided with temperature recorders for observing regeneration temperatures.

Feed-Stock Inspections. Feeds of three distinct boiling ranges are charged to the reformers in blocked operation. In this way, an optimum operating condition can be achieved for each feed. Table 1 presents typical feed-stock inspections. The feed stocks are desulfurized and fractionated at another unit and are stored in intermediate tankage.

Product Yields and Inspections. Typical product yields for each type of feed are presented in Table 2. The inspections on the debutanized product are presented in Table 3. These data are presented at two levels of severity for each feed. It will be noted that the data are presented for severities of 93 and 97 octane number for the two lighter feeds and 90 and 93 octane number for the heaviest feed. Since coke production increases as the boiling range of the feed increases, the heaviest fed is usually not reformed as severely as the lighter feeds. The maximum severity attempted to date was 100 octane number, when the fed with a final boiling point of 270 F. was charged. The stabilized reformate from this operation had a 103.8 Research octane number, with the addition of 3 ml TEL per gallon.

Catalyst Deactivation. A platinum catalyst can be permanently poisoned by heavy metals such as molybdenum, arsenic, and lead. This is usually not a problem if the feeds are prepared as overhead distillates, as is now done by Humble Oil & Refining Company. Careful sandblasting of the lines and equipment prevented molybdenum poisoning of the catalyst when the old molybdena reformer was converted for platinum. Sulfur is a temporary platinum-catalyst poison. To prevent this effect, the reformer feed stocks were originally desulfurized to less than 200 ppm of sulfur. Corrosion and scale considerations dictate a still lower sulfur level. Coke on the catalyst causes deactivation. However, the regeneration techniques employed by Humble Oil & Refining Company have been very successful in burning off the coke from the catalyst, thereby restoring its activity.

Catalyst Activity. The activity maintenance of the catalyst used in Humble Oil & Refining Company's platinum reformers has been exceptionally good. An average catalyst activity of 85 percent of fresh catalyst has been achieved since the startup of the units. On one occasion the activity of the catalyst declined to as low as 10 percent. However, regeneration techniques successfully restored the catalyst to the fresh level. This extreme decline in catalyst activity was caused by insufficient regeneration and scale, which had partially plugged the catalyst beds. A plot of the catalyst activity for the new unit is shown in Figure 2. The catalyst in one reactor has now achieved a life of approximately 60 barrels of feed per pound of catalyst, with no indication of permanent activity decline. The oldest catalyst in the units has been on oil 450 days to date. An ultimate life of at least two years is now anticipated.

Regeneration. The platinum catalyst is reactivated by the process of regeneration. The reactor which is to be regenerated is replaced in the reaction sequence by the swing reactor, it is purged of heavy hydrocarbons with recycle gas, and it then receives an inert-gas purge. After purging, a flue gas containing approximately 2 percent of oxygen is passed over the catalyst at a temperature between 800 F. and 1050 F. When the coke burn is completed, the reactor is purged with inert flue gas, followed by a recycle-gas purge, and is placed back on reaction. The double block valve and seal-gas system is operated during regeneration, as previously discussed. Each reactor is regenerated at about six-day intervals. Generally, approximately 0.5 to 1.5 percent by weight of coke is burned during each regeneration.

Corrosion and Scale. The principal difficulties encountered in the operation of Humble Oil & Refining Company's platinum reformers have been caused by sulfur and hydrogen sulfide corrosion of the hydrocarbon piping, which has resulted in metal loss and scale formation. Sulfur corrosion rates of 200 mils per year were experienced in the carbon-½ percent molybdenum tubes of the naphtha preheat furnace at the new reformer. This

TABLE 3

Inspections on Debutanized Reformate

Feed nominal boiling range, deg. F.	200 to 270		260 to 310		300 to 370	
ASTM octane number (D 908, Research Method);						
Without TEL addition	93.0	97.0	93.0	97.0	90.0	93.0
With addition of 3 ml TEL per gal.	100.0	102.0	99.5	101.6	97.2	98.9
ASTM octane number (D 357, Motor Method);						
Without TEL addition	82.9	86.4	82.8	86.3	80.4	82.7
With addition of 3 ml TEL per gal.	92.0	94.7	91.1	93.8	88.2	90.0
Gravity, deg API	45.8	44.4	43.0	40.7	41.3	40.5
Reid vapor pressure, psi	3.5	4.5	2.6	3.6	1.6	2.0
ASTM distillation, deg F;						
Initial boiling point	162	135	172	143	152	146
5-percent point	199	187	220	200	215	210
10-percent point	210	200	247	236	260	252
20-percent point	219	214	262	257	290	285
30-percent point	226	222	274	274	307	305
40-percent point	230	228	282	284	318	315
50-percent point	235	234	289	292	322	323
60-percent point	240	239	294	298	328	329
70-percent point	244	244	299	303	337	338
80-percent point	254	254	307	310	344	346
90-percent point	269	270	315	319	355	358
95-percent point	283	287	323	328	375	379
Final boiling point	313	325	358	383	426	432
Hydrocarbon type, percent by volume;						
Aromatics	59.5	65.0	59.9	70.6	55.5	62.0
Paraffins	37.0	33.0	36.5	26.0	34.5	31.5
Naphthenes	2.0	0.0	2.3	1.5	9.0	5.3
Olefins	1.5	2.0	1.3	1.9	1.0	1.2

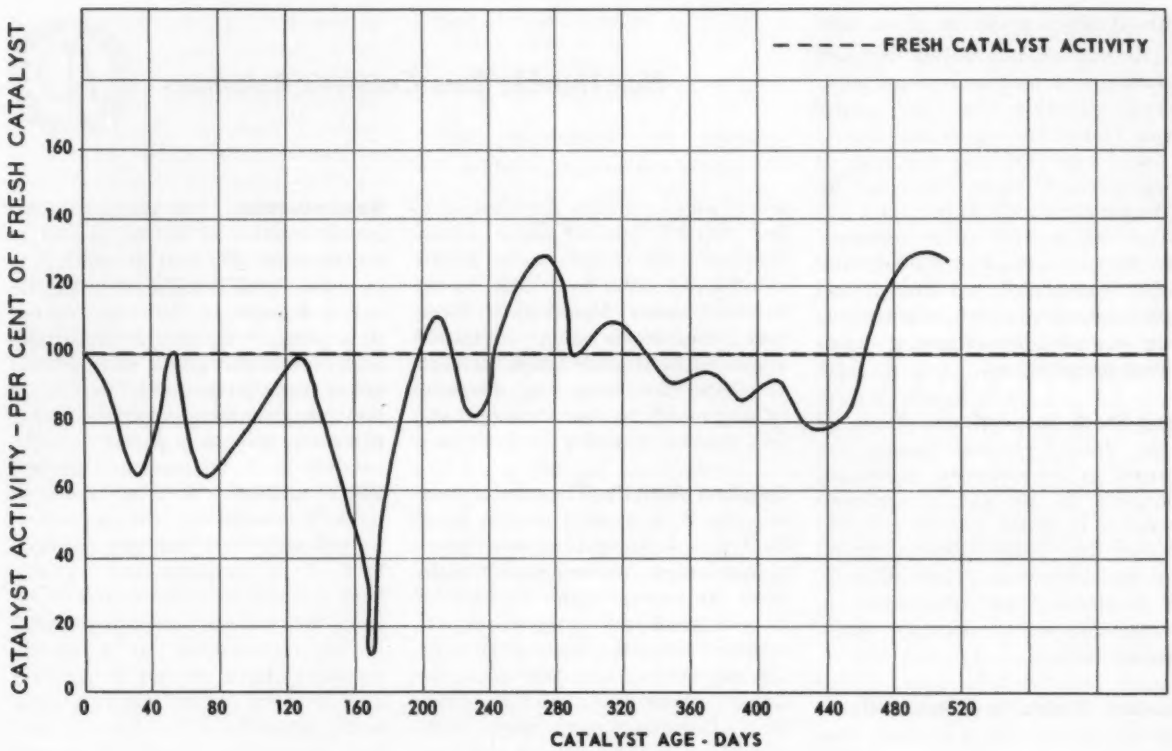


FIGURE 2—Catalyst activity: Anticipated life is two years.

furnace has since been retubed with 9 percent chrome-1 percent molybdenum tubes. Hydrogen sulfide corrosion rates of approximately 60 to 90 mils per year have been experienced in the low-chrome molybdenum reheat tubes and transfer lines at this same unit. No corrosion was found in the 18 percent chrome-8 percent nickel tubes in the converted reformer. However, the same experience was obtained with low-chrome molybdenum metals as at the new unit.

In addition to the problem of metal loss, the scale flakes off the furnace tubes and transfer lines and plugs up the catalyst beds. The result is high-pressure drop and poor catalyst-bed distribution, which reduces the effectiveness of the catalyst. Because the reformers are equipped with double block valves, it has been possible to blind off a reactor, and to dump and screen the catalyst. The catalyst is reloaded, and activity is restored by regeneration. The permanent solution to the problem of corrosion and scale will be the installation of a hydrodesulfurization unit designed to reduce the sulfur levels of the reformer feed to less than 25 ppm.

Other Operating Problems. Among the other problems encountered in the operation of the reformers has been the coking of feed heat exchangers. This was caused by upset of the gas-blanketing system on the reformer feed tankage. The purpose of the gas blanket is to prevent oxygen from being absorbed into the feed. Dissolved oxygen can result in exchanger coking and fouling at the point in the system where the naphtha becomes entirely vaporized. Early in the operation of the units, catalyst attrition resulted from the high velocity of the vapor entering into the reactors. New reactor entrance baffles have eliminated this problem.

Original presentation was before the American Petroleum Institute, Division of Refining, Philadelphia, May 13-16, 1957.

About the Speaker

H. C. NIX received his B.S. degree in chemical engineering from Virginia Polytechnic Institute in 1949. He works in Humble Oil & Refining Co.'s Technical Service division where for the past four years he has been dealing directly with hydroforming.

BIBLIOGRAPHY

M. Sittig and W. Warren. "How to Get Those Top Octanes," Petroleum Refiner 34 [9] 230-80 (1955).

How to Make 110 Octane Premium

Cost case is developed for 50,000 bpd refinery, showing stepwise addition of processes to meet future gasoline quality.

S. P. Blumberg, Humble Oil & Refining Company, Baytown, Texas

CONSUMER ACCEPTANCE indicates the horsepower race will continue.[1] Keeping pace with this demand for greater performance creates the octane race. Extrapolations of current trends indicate that high-performance cars of 1960 will require a premium motor fuel of about 110 Research octane number.

Trends in compression ratios have been upward.[2,6] Starting in 1946, the weighted average compression ratio of new cars increased at a rate of less than one-half compression ratio every four years. In 1953 a rather abrupt change occurred, and the average compression ratio of new cars started upward at a rate of one-half compression ratio per year.[7] An extrapolation of this trend indicates that by 1960 the average compression ratio of the new cars will be above 10:1 and that of the high-performance

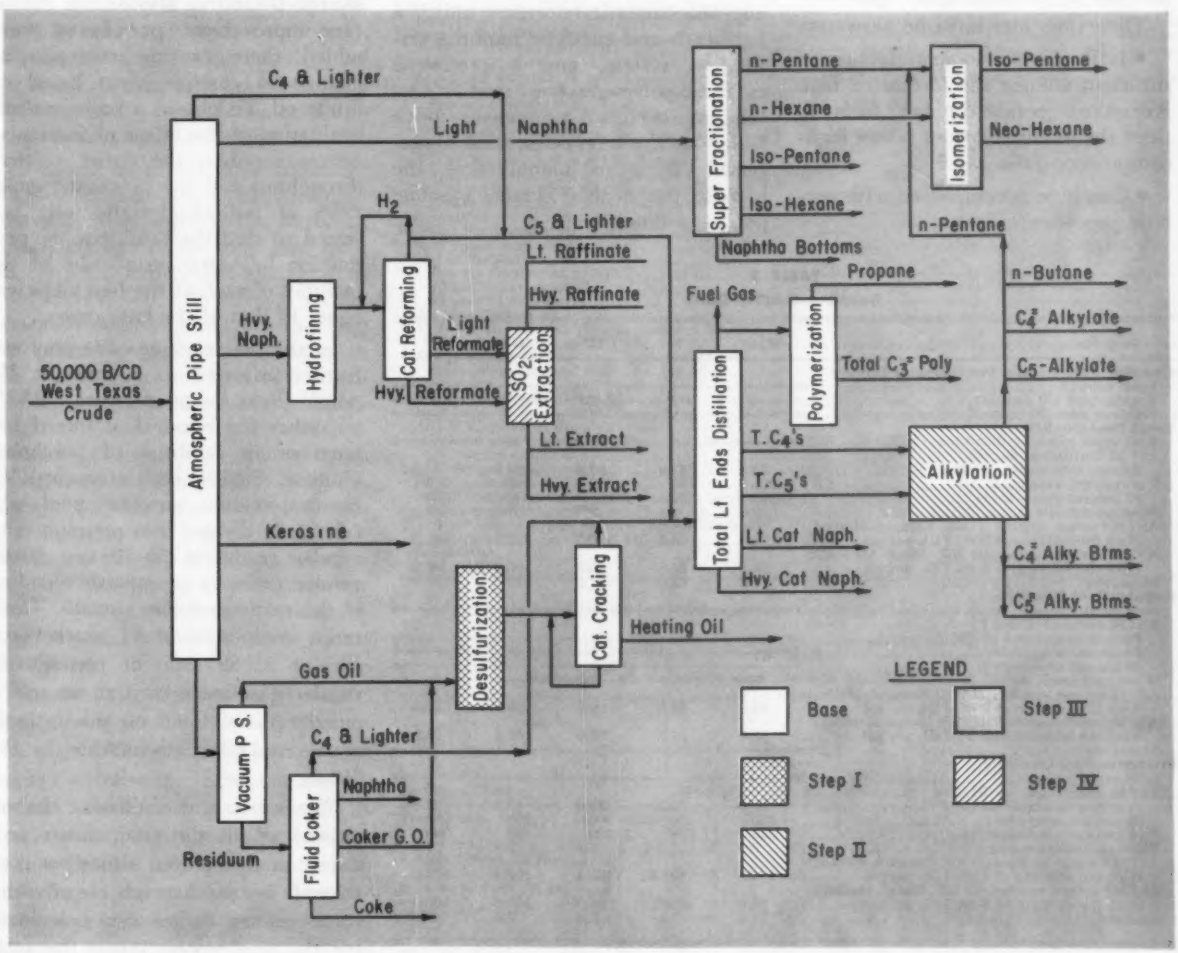


FIGURE 1—Refinery block diagram showing the addition of the various processing units for steps I, II, III, and IV.

cars in the same year could exceed 12:1.[3]

By projecting recent octane-requirement trends, it is estimated that the high-performance cars of 12:1 compression ratio will require a gasoline of approximately 110 Research octane number, and the average new car will require a gasoline of approximately 100 Research octane number.[2,6] Octane numbers above 100 are expressed by the Wiese formula,

$$\text{Octane Number} = 100 + \frac{\text{PN} - 100}{3}$$

in this article.

With existing octane-improvement facilities, refiners are now manufacturing premium-grade gasolines having 95 to 100 Research octane number. If the continued upward trend in automobile-engine compression ratios is maintained with corresponding increases in fuel octane-number requirements, refiners must plan future process requirements to meet a projected 10 to 15 Research octane increase in premium-grade gasolines.

These questions must be answered:

- Is it possible to manufacture in sufficient volume the forecasted high Research octane-number fuels to meet the requirements of future high-compression-ratio cars?
- Can it be accomplished with current processes?
- What investments and manufacturing costs will be incurred?

Here we will discuss these questions from a refiner's viewpoint.

Refining Facilities. As a basis for the study, it was decided to consider a relatively small, new, and efficient refinery, constructed for the major purpose of producing increasingly higher octane-quality premium gasolines by the stepwise addition of established commercial octane-improvement processes.[9] The following assumptions were made concerning its operations:

1. That it would be an ultimate yield, inland refinery, (away from tidewater) charging sour West Texas crude oil at a rate of 50,000 barrels per calendar day, and,

2. That in the base case the processing equipment would consist of a 2-stage pipe still, a fluid catalytic-cracking unit, a fluid-coking unit, a hydrofining unit,[10] a regenerative naphtha catalytic-reforming unit,[11] a light-ends and catalytic naphtha distillation system, and a propylene catalytic-polymerization unit.[12] Octane-improvement processes were added to the base refinery in 4 successive steps to manufacture the highest practicable octane gasoline pool, as follows:

Step I An increase in catalytic-reforming severity was made to yield a total reformate of 100 instead of 95 Research octane number, clear, and a desulfurization unit[13] was added to pretreat the total catalytic-cracking gas-oil feed.

Step II A sulfuric-acid alkylation unit was added to process segregated butylene and pentylene feeds.[9]

Step III A superfractionation unit was added for fractionating the light virgin naphtha to yield *iso*pentane and *iso*hexane concentrates; an isomerization unit was added for processing the segregated *n*pentane and hexane concentrates.[14,15]

Step IV An extraction unit was added for segregating the aromatics from the light and heavy reformate fractions.[16]

Figure 1 presents a simplified flow diagram of the refinery.

Motor-Gasoline Blends. As the octane-improvement processes were added, there was an accompanying change in gasoline yield based on crude oil. To obtain a more realistic evaluation of the effect of increasing octane number, the entire refinery throughput and the processing capacities of individual units were adjusted so that the total gasoline production following installation of the facilities of each of the four steps was equal to that of the base case.

In addition, each gasoline pool was further adjusted to a constant 10-pound Reid vapor pressure (RVP) by either the removal of mixed butanes or the addition of purchased *n*butane. Finally, each constant-RVP constant-volume gasoline pool was arbitrarily divided into premium and regular grades in 30:70 and 40:60 volume ratios by appropriate blending of the various refinery streams. These ratios were selected to bracket the current 31:69 ratio of premium to regular gasoline sales and an anticipated upward trend on this ratio as octane requirements increase in the future.

The octane and distillation characteristics of all the components produced in the various situations considered were known, and the corresponding values were calculated for the total pools. When the total pools were divided into 30 percent

TABLE 1
Gasoline-Quality Data

Step No.	Base	I	II	III	IV
Gasoline Volume, Bbl Per Calendar Day:					
Total pool	←		29,729		→
Regular pool (70 percent)	←		17,837		→
Premium pool (30 percent)	←		11,892		→
Total Pool Quality:					
Reid vapor pressure, lb (adjusted)	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.1	32.9	30.6	34.0	32.2
50 percent evaporated	201	196	209	213	217
90 percent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	99.4	100.5	102.2	102.5
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.2	86.8	89.3	90.2	90.3
Sensitivity	11.8	12.6	11.2	12.0	12.2
Regular Pool Quality:					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	←		30		→
50 percent evaporated	←		212		→
90 percent evaporated	←		332		→
Warmup-demerit rating	←		3.0		→
ASTM octane number (D 908, Research Method:					
With the addition of 3 ml TEL per gal	98.0	98.5	99.0	99.5	99.5
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.0	86.5	87.0	87.5	87.5
Sensitivity	←		12		→
Premium Pool Quality:					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.3	39.7	32.0	43.3	37.0
50 percent evaporated	180	166	202	213	238
90 percent evaporated	340	328	320	320	349
Warmup-demerit rating	2.0	1.5	2.4	2.8	4.2
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	102.4	105.4	109.4	110.8
ASTM* octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.6	88.6	99.0	101.6	102.0
Sensitivity	11.4	13.8	6.4	7.8	8.8

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{\text{PN} - 100}{3}$

premium and 70 percent regular grades, the Research and Motor octane numbers of the regular pools were allowed to increase gradually from the base through Step IV from 98.0 to 99.5 and from 86.0 to 87.5, respectively. In the division of the pools into 40 percent premium and 60 percent regular grades, the Research and Motor octane values of the regular grades were maintained constant at 98.0 and 86.0, respectively, to permit production of the same quality premium fuels as were produced with the 30:70 ratio of premium-to-regular fuel division. In all cases the volatility characteristics of the regular grades were maintained constant.

The volatilities and octane qualities of the total, premium, and regular fuels for the 30:70 and 40:60 divisions are presented in Table 1 and Table 2, respectively. It was found that all of the regular and premium fuels represented practical blends which could be produced in the refinery facilities employed.

Volatility and octane qualities of the total, regular, and premium fuels for each of the steps shown in Table 2 are summarized in Table 3.

It will be noted that the cumulative effect of the octane-improvement processes is to upgrade the Research octane number of the total pool from 98.0 to 102.5 and that of the premium pool from 98.0 to 110.8. Note that the Research octane number of the Step IV premium grade is equivalent to the value forecasted for 12:1 compression-ratio cars. As shown in Table 3, the warmup demerits for the premium fuels increased significantly in going from the base case to Step IV. Except for this, the study indicates that installation of currently available processes, coupled with operation at high-severity levels, may well answer the needs of the refiners to meet future required octane qualities up to this point.

In recent years, trends in engine design have resulted in an increase in the speed of knock, and Motor octane ratings relative to Research octane ratings have become greater factors in road-octane performance. As a result, it may become increasingly important to maintain the sensitivity of the gasolines at a value of 10 or less in the future.[17] As anticipated, premium-fuel sensitivity increased when reforming severity was increased (11.4 to 13.8; Step I over base), and then decreased significantly as alkylation was added.[11] Sensitivity following Step IV was only 6.5.

It should be emphasized that Step IV represents utilization of a large amount of alkylate in motor gasoline relative to normal refinery practices. For example, the target Research octane quality of 110 can be met without the use of alkylate, as shown in Table 4. In this case, the use of a large amount of aromatics resulted in a sensitivity of 10.0. On this basis it would be questionable for car manufacturers to rely upon a sensitivity of less than 10.

The vapor-lock and warmup characteristics of a fuel are known to be influenced by its RVP and distillation characteristics. The vapor-locking tendencies of a fuel are often characterized by its vapor pressure and the percentage evaporated at 158 F., as described in a paper by Barnum, Clarke and Hamer.[18]

All of the fuels in Table 2 are rea-

TABLE 2
Gasoline-Quality Data

Step No.	Base	I	II	III	IV
Gasoline Volume, Bbl Per Calendar Day:					
Total pool	←		29,729		→
Regular pool (60 percent)	←		17,837		→
Premium pool (40 percent)	←		11,892		→
Total Pool Quality:					
Reid vapor pressure, lb (adjusted)	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.1	32.9	30.6	34.0	32.2
50 percent evaporated	201	196	209	213	217
90 percent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
ASTM* octane number D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	99.4	100.5	102.2	102.5
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.2	86.8	89.3	90.2	90.3
Sensitivity	11.8	12.6	11.2	12.0	12.2
Regular Pool Quality:					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	←		30		→
50 percent evaporated	←		212		→
90 percent evaporated	←		332		→
Warmup-demerit rating	←		3.0		→
ASTM octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	←		98		→
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	←		86		→
Sensitivity	←		12		→
Premium Pool Quality:					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.3	37.3	31.5	40.0	35.5
50 percent evaporated	193	184	206	213	228
90 percent evaporated	342	330	325	325	348
Warmup-demerit rating	2.4	1.9	2.6	2.9	3.7
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	102.4	105.4	109.4	110.8
ASTM* octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.6	88.6	98.0	103.5	104.3
Sensitivity	11.4	13.8	6.4	5.9	6.5

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{PN - 100}{3}$

TABLE 3
Summary of Volatility and Octane Qualities from Table 2

Pool and Step	RVP (Pound)	Percent Evaporated at 158 F.	Warmup Demerit	ASTM* Octane Number with the Addition of 3 Ml TEL Per Gallon		
				Research	Motor	Sensitivity
Total Pool:						
Base	10	30	2.6	98.0	86.2	11.8
Step IV	10	32	3.3	102.5	90.3	12.2
Regular Pool (60 Percent):						
All steps	10	30	3.0	98.0	86.0	12.0
Premium Pool (40 Percent):						
Base	10	30	2.4	98.0	86.6	11.4
Step IV	10	36	3.7	110.8	104.3	6.5

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{PN - 100}{3}$

About the Speaker

S. P. BLUMBERG is a senior research chemical engineer at Humble Oil & Refining Co.'s Baytown refinery. He is presently engaged in motor and jet fuel research. Blumberg received his B.S. degree in chemical engineering from the University of Texas in 1943.

sonably similar and are satisfactory from the standpoint of vapor lock. The warmup characteristics of a gasoline are controlled primarily by mid- and backend volatilities. Moore, Young and Toulmin have correlated warmup performance with ambient temperature and the 50 percent and 90 percent evaporation temperatures of the fuel.[19,20] This correlation was employed to obtain the warmup-demerit ratings shown in Tables 1, 2, 4 and 7. Fuels with high 50 percent and 90 percent distillation temperatures exhibit poor warmup characteristics and, consequently, have the highest demerit ratings. It is important to note that the warmup-demerit rating of the premium fuels increased from 2.0 to 4.2 for the base case over Step IV (Table 1) and from 2.4 to 3.7 for the base case over Step IV (Table 2). The rapid rise in demerit rating was experienced as the concentration of the high-boiling, high-octane alkylates and aromatics was increased. This emphasizes the fact that the warmup problem will likely gain in importance as the octane levels continue to rise.[19]

TABLE 4
Octane-Quality Data of Experimental Blends

	Blend No. 1	Blend No. 2	Blend No. 3
Component Composition, Percent by Volume:			
Light *iso*paraffins (C_4, C_5, and C_6)	42	28	35
Mixed alkylate	20	20	...
Purified aromatics (toluene, xylene, and C_9)	38	52	65
Inspection Data:			
Reid vapor pressure, lb	11.2	12.3	12.3
ASTM distillation, deg F:			
Precent evaporated at 158 F	18	23	25
50 percent evaporated	242	238	217
90 percent evaporated	300	300	302
Warmup-demerit rating	3.9	3.5	2.6
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	105	107	110
ASTM octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	100	99	100
Sensitivity	5	8	10

* Octane numbers above 100 by the Wiese formula, Octane Number $= 100 + \frac{PN - 100}{3}$

TABLE 5
Material Balance, Economics, and Investments*

	Base			IV		
Step No.	**Barrels Per Calendar Day**	**Cents Per Gallon**	**Dollars Per Calendar Day**	**Barrels Per Calendar Day**	**Cents Per Gallon**	**Dollars Per Calendar Day**
Raw Stock and Degradation Costs						
Crude oil	50,000	7.26	152,500	45,165	7.26	137,753
*n*Butane	.....	.....	.....	1,272	5.00	2,671
*iso*Butane	.....	.....	.....	2,102	8.00	7,062
Gas (or equivalent fuel)†	(3,104)	0.15†	(2,794)	(2,343)	0.15†	(2,109)
LPG (C_3)	(1,369)	3.50	(2,012)	(1,328)	3.50	(1,952)
Mixed C_4's	(1,982)	10.00	(8,324)	.....	10.00	.....
Kerosine	(7,300)	7.50	(22,995)	(7,651)	7.50	(24,101)
Heating oil	(7,544)	7.00	(22,179)	(7,524)	7.00	(22,121)
Coke‡	(966)	11.00‡	(2,596)	(900)	11.00†	(2,343)
Gasoline, regular	(17,837)	12.50	(93,644)	(17,837)	12.50	(93,644)
Loss	2,024	.....	.....	936	.....	.....
Gasoline, premium§	(11,892)	.....	.....	(11,892)	.....	.....
Net Costs‡	0	.....	(2,044)	0	.....	1,216
Operating Costs	.....	.....	39,191	.....	.....	56,504
Premium Gasoline	11,892	12.50	62,432	11,892	18.57	92,745
Total Investment, In Millions of Dollars	.....	.....	46	.....	.....	64

* Figures in table which appear in parenthesis are credits.
† Fuel-gas value, at 15 cents per million Btu.
‡ Coke value, at $11 per ton.
§ Costs established by difference, as shown previously.
‡ Net costs or credits, excluding premium gasoline.

Octane-Improvement Costs. As stated earlier, the refiner is concerned with the magnitude of the investments and operating costs that will be incurred in meeting the future octane requirements. Investments and operating costs are quite specific to any refinery, and a detailed consideration of a single refinery would not likely yield information of general applicability. Moreover, there are uncertainties as to future costs and product values. In a partial attempt to indicate an order of magnitude of future octane-improvement costs, the generalized 50,000-barrel-per-calendar-day refinery was selected.

It was estimated that this refinery would cost $46 million, or approximately $920 per daily barrel of crude-oil charging capacity; this figure is believed to be within the range of costs of constructing such a refinery today.

Estimates of investments for integrating the processing facilities for each successive step considered would be expected to vary substantially, depending upon the existing situation and the expected ultimate situation.

Accordingly, a single estimate was prepared, covering the cost of a new refinery containing all of the facilities through Step IV. This investment would be on the order of $64 million, which is some 39 percent greater than that for the base refinery, for the same motor-gasoline production but of the higher octane quality.

Operating costs and product values were selected as being reasonably typical of the assumed situations. In order to obtain an indication of the cost of octane improvement, refinery realizations on all products except premium gasoline were held constant. Raw-stock costs, operating cost, and product values for the base case and for completion of Step IV facilities are presented in Table 5.

The results presented in Table 2 and Table 5 for the base and Step IV are summarized in Table 6.

The inclusion of all the improve-

ment processes in Step I through Step IV effected an increase in the Research and Motor octane numbers of 12.8 and 17.7, respectively, for an added cost of 6.1 cents per gallon. This is equivalent to Research octane-number barrel and Motor octane-number barrel improvement costs of 19.9 cents and 14.4 cents, respectively. These costs are not to be considered additive, inasmuch as each was calculated from the same difference (6.1 cents per gallon, in manufacturing cost.

Table 2 shows that all of the added processes contributed almost equally to the rise in the Research octane number of the premium pool; however, the Motor octane increase was gained primarily through the use of alkylate. If the sensitivity of a fuel continues to exhibit an important influence on its road-octane rating, refiners will continue to examine all processes from the standpoint of both types of octane-improvemnt costs. The study indicates that obtaining further increases in octane quality will become much more difficult and considerably more expensive.[21]

Effect of Producing Aviation Gasoline. Many refineries have commitments to supply aviation gasoline as well as two or more grades of motor gasoline. An analysis was made to determine the quality effect on the premium motor-gasoline pool, if sufficient components were first made available for the production of 10 percent of grade 115/145 aviation fuel; and the remaining pool, after a readjustment to 10-pound RVP, was then divided into 40 percent premium- and 60 percent regular grade motor fuels. Table 7 presents the distillation and octane qualities obtained for Step II, Step III and Step IV. These data may be compared with data from Table 2 in Table 8.

As would be expected, losses in Research octane (1.8 to 2.5), Motor octane (4.4 to 6.6), and the midvolatility (6 F. to 10 F.) and substantial increases in sensitivity (2.6 to 4.1) occurred when alkylate was removed to produce aviation fuel. These data serve to emphasize again that future premium gasolines may well have sensitivities above 10, if the production of aviation gasoline remains at substantial levels.

Effect of a Three-Grade System for Marketing Motor Gasoline. A number of gasoline manufacturers are currently marketing 3 grades of motor fuel while others are continuing to market only 2 grades. To show the effect of employing a 3-grade system, the total gasoline pool of Step II was divided into 3 grades according to the percentage figures shown in Table 9. The Research octane numbers of the first and third grades were

TABLE 6

Summary of the Results Shown in Table 2 and Table 5 for the Base and Step IV

Step No.	Base	IV
Premium Gasolines		
Qualities		
ASTM* octane number (D 908, Research Method):		
With the addition of 3 ml TEL per gal	98.0	110.8
ASTM* octane number (D 357, Motor Method):		
With the addition of 3 ml TEL per gal	86.6	104.3
Manufacturing cost, cents per gal	12.5	18.6
Octane-Improvement Costs		
Research above base, cents per Research octane-number bbl	....	19.9
Motor above base, cents per Motor octane-number bbl	....	14.4

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{PN-100}{3}$

TABLE 7

Effect of Producing 10 Percent Aviation Gasoline

Step No.	II	III	IV
Total Gasoline-Pool Volume, Bbl Per Calendar Day	←	29,729	→
Regular	←	15,941	→
Premium	←	10,628	→
Aviation grade 115/145	←	2,973	→
Aviation Grade 115/145 Quality			
Reid vapor pressure, lb	←	7	→
ASTM distillation, deg F:			
Percent evaporated at 158 F	←	30	→
50 percent evaporated	←	205	→
90 percent evaporated	←	287	→
Warmup-demerit rating	←	1.7	→
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	←	108.0	→
ASTM* octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	←	102.0	→
Sensitivity	←	6	→
Regular Pool Quality†			
Premium Pool Quality			
Reid vapor pressure, lb	←	10	→
ASTM distillation, deg F:			
Percent evaporated at 158 F	29.9	33.6	31.6
50 percent evaporated	212	213	238
90 percent evaporated	300	295	357
Warmup-demerit rating	2.4	2.3	3.6
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	103.6	107.0	108.3
ASTM octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	94.6	97.3	97.7
Sensitivity	9.0	9.7	10.6

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{PN - 100}{3}$

† The same quality as shown in Table 2.

TABLE 8

Comparison of Data From Table 7 and Table 2

Step No.	II (Percent)		III (Percent)		IV (Percent)	
Aviation Gasoline Sales	**0**	**10**	**0**	**10**	**0**	**10**
Premium Fuels						
ASTM* octane number (D 908, Research Method):						
With the addition of 3 ml TEL per gal	105.4	103.6	109.4	107.0	110.8	108.3
ASTM* octane number (D 357, Motor Method):						
With the addition of 3 ml TEL per gal	99.0	94.6	103.5	97.3	104.3	97.7
Sensitivity	6.4	9.0	5.9	9.7	6.5	10.6
ASTM distillation, deg F:						
50 percent evaporated	206	212	213	213	228	238

* Octane numbers above 100 by the Wiese formula, Octane Number = $100 + \frac{PN - 100}{3}$

TABLE 9

Effect of Three-Grade System Gasoline Marketing

	Percent by Volume of Total Pool	ASTM* Octane Number (D 908, Research Method): With the Addition of 3 Ml TEL Per Gallon	ASTM* Octane Number (D 357, Motor Method): With the Addition of 3 Ml TEL Per Gallon	Reid Vapor Pressure (Pounds)
Three-Grade—Step II				
First grade	15	110.8	101	10
Second grade	35	102.4	89	10
Third grade	50	98.0	86	10
Two-Grade—Step IV				
Premium	40	110.8	104.3	10
Regular	60	98.0	86.0	10

* Octane numbers above 100 by the Wiese formula, Octane Number $= 100 + \frac{PN-100}{3}$

fixed, and the second grade was then calculated by the difference. The Research octane number of the first- and third-grade fuels purposely were selected to be identical to the premium and regular grades of Step IV in Table 2. It should be noted that by dividing the Step II pool into 3 grades, a manufacturer could satisfy essentially the same percentage of high- and low-compression-ratio cars as the 2-grade system of Step IV, without a substantial additional refinery investment for facilities such as isomerization and extraction of catalytic reformates.

Original presentation was before API Division of Refining meeting, Philadelphia, May 14, 1957.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Humble Oil & Refining Company for permission to publish this paper and is indebted to A. A. Draeger, R. E. Dugat, M. R. Morrow, and N. P. Peet for their valuable assistance in the preparation of the paper.

LITERATURE CITED

[1] *Ward's Automotive Repts.* 32 [2] Jan. 14 (1957).

[2] P. H. Richard. "Looking Ahead from Detroit." *Du Pont Tech. Notes* Sept. (1956).

[3] C. L. McCuen. "Economic Relationship of Engine-Fuel Research." *Proc. API* 31M [III] 197-220 (1951).

[4] E. V. Murphree, "Fundamentals of Fluid Hydroforming," PETROLEUM REFINER 30 [12] 97-108 (1951).

[5] E. V. Murphree, A. R. Cunningham, J. P. Haworth, and A. F. Kaulakis, "The Trend to High Octane Number Gasoline Is Sound," paper presented at an SAE section meeting, New York, N. Y., Oct. (1953).

[6] G. Weber, "How High Are Octanes Going and How Will They Get There?" *Oil Gas J.* 54 [46] 186-192 (1956).

[7] D. F. Caris, B. J. Mitchell, A. D. McDuffie, and F. A. Wyczalek, "Mechanical Octanes for High Efficiency," paper presented at an SAE summer meeting, Atlantic City, N. J., June (1955).

[8] W. M. Wiese, "The Winning Side—Extend Octane Scale," PETROLEUM REFINER 35 [7] 166 (1956).

[9] A. A. Draeger, G. T. Gwin, C. J. G. Leesemann, and M. R. Morrow, "Production of High-Octane Gasoline Components," PETROLEUM REFINER Part I 30 [8] 71-6 (1951); Part II—Processes 30 [9] 107-111 (1951); Part III 30 [11] 139-141 (1951).

[10] A. C. Patterson and M. C. K. Jones, "Hydrofining's Use in Product Improvement," *Oil Gas J.* 53 [24] 92-4 (1954).

[11] M. Sittig and W. Warren, "How to Get Those Top Octanes," PETROLEUM REFINER 34 [9] 230-280 (1955).

[12] P. C. Weinert and G. Egloff, "Catalytic Polymerization and Its Commercial Application," *Petroleum Processing* 3 [6] 585-593 (1948).

[13] E. H. Lewis, "Hydrofining Catalytic Cracking Feed Stocks," *Oil Gas J.* 54 [11] 95-6 (1955).

[14] W. S. Nordberg and R. C. Arnold, "Higher Octanes by the Isomate Process," *World Petroleum* 27 [8] 68 (1956).

[15] J. E. Swearingen, R. D. Geckler, and C. W. Nysewander, "The Isomate Process," *Trans. Am. Inst. Chem. Engrs.* 42 573 (1946).

[16] C. H. Marshall, "Production of Aromatics," *Chem. Eng. Progr.* 46 [6] 313 (1950).

[17] F. T. Finnigan and A. W. Percy, "New Concepts in Use of Blending Stock," *Oil Gas J.* 54 [60] 84-90 (1956).

[18] R. E. Barnum, P. J. Clarke, and J. P. Hamer, "Vapor-Lock Characteristics of Passenger Cars," paper presented at an SAE summer meeting, Atlantic City, N. J., June (1954).

[19] G. T. Moore, R. D. Young, and H. A. Toulmin, "Effect of Fuel Volatility on Starting and Warm-Up of New Automobiles," paper presented at an SAE national fuels and lubricants meeting, Tulsa, Okla., Nov. (1956).

[20] P. C. White, "Turnpikes and Traffic Test Modern Engines," *J. Soc. Automotive Engrs.* 63 [12] 58 (1955).

[21] R. C. Kersten and W. T. Warren, "Common Cents per Research Octane Number Barrel," paper presented at the 44th Meeting of the Western Petroleum Refiners Assoc., San Antonio, Texas, March (1956).

More About Fuels

Knock Performance. Antiknock behavior and combustion-chamber deposit phenomena have been studied to determine their importance on gasoline design. Ethyl Corporation Research Laboratories have conducted these investigations by controlled tests of high compression engines on the road.

Using three 11:1 compression ratio engines the relationship between gasoline characteristics and knock-limited performance have been studied. Various correlations among Research octane number, sensitivity hydrocarbon composition, and volatility are discussed. Fuel compositions reflecting the use of current and prototype components have been studied. Hydrocarbon composition is expected to be an important factor in gasoline design.

To study effects of combustion-chamber deposits expected at the 100 octane level, three 100 octane gasolines of varying aromatic and olefin content were blended. Carefully controlled road tests were conducted to determine:

1. Stabilized knock and surface ignition requirements with both primary and commercial-type reference fuels.

2. Spark plug fouling tendencies.

Each fuel was run in each of nine cars, all at 10:1 compression ratio. There were three cars for each of three different makes. Similar tests were conducted in multi-cylinder engines on the dynamometer. The relative tendencies of the fuels to be surface ignited by stabilized deposits were also determined.

("Matching Gasoline Antiknock Performance and Future Engines," T. W. Warren, H. A. Toulmin, J. B. Retzloff and C. A. Hall, Ethyl Corp., Detroit, Mich. at the FUELS SESSION, Tuesday, May 14, 1957.)

Tomorrow's Fuels. Every refiner is concerned with the problem of selecting process equipment which will enable him to market the high octane number fuels which tomorrow's cars will require. He can determine costs, yields, and laboratory octane numbers for the various processes available. Here is the factual information on road performance of whole fuels in high compression ratio cars for various alternatives. Much of this information has been lacking.

A careful study was made of the new processes and of some possible ways of combining these new components. Many blends were selected to cover practical premium fuel blends which could be marketed in the next two or three years. These were carefully tested in cars having compression ratios from 9:1 to 12:1. Other probable changes in engine design have been built into the test program. These data give refiners information which provide a basis for selecting new processes and for blending stocks to give optimum road performance.

("Road Octane Numbers of Tomorrow's Gasolines in Tomorrow's Cars," J. J. Greytak, J. S. Gellah and W. E. Morris, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del. at the FUELS SESSION, Tuesday, May 14, 1957.)

Low pH vs. High pH in Crude Oil Units

Here's a report of the results obtained by maintaining high-pH and low-pH in a crude unit's overhead receiver water.

J. A. Biehl and E. A. Schnake, The Ohio Oil Company, Robinson, Ill.

THE OHIO OIL COMPANY made studies of operation and corrosion of their crude oil unit at high pH and low pH control of overhead receiver waters. These studies resulted in the reduction of the pH of receiver waters to an average 4.3, with inhibitor injections varying from 10 ppm to 15 ppm. After 27 months of operating under these conditions after-effects have been eliminated and corrosion data indicate excellent protection of equipment.

The refineries most widely used method of corrosion control was to maintain the pH of receiver waters at levels of 7.0 or higher by the injection of ammonia. However, it was found that the use of ammonia had adverse effects on subsequent refinery processes and often resulted in more severe corrosion of such processing equipment.

Experiences at High pH. The crude oil unit was originally placed onstream at a charge rate of 25,000 barrels per day. During all of the initial runs, the pH of the desalter effluent was maintained at 8.6 and the pH of the reflux accumulator water controlled between 6.8 and 7.5. With this charge rate, the corrosion was rather mild. But the charge rate later was increased slowly to 36,000 barrels per day. After a year's operation, the unit was inspected and corrosion and fouling were rather severe.

During the next run, amine-type corrosion inhibitors were evaluated. The comparison was made by means of test coupons, water analysis and hydrogen probe activity. Without inhibitor injection, hydrogen activity was high, with a pressure accumulation of 89 pounds per square inch in approximately 30 days. With inhibitor injection, hydrogen activity was practically nil. As a result of the inhibitor evaluation program, it was decided that both ammonia and inhibitor injection should be used for corrosion protection.

During the following year's run, an amine-type inhibitor was injected continuously into the atmospheric overhead vapor line at a rate of 6 parts per million of the total overhead. The hydrogen probe activity during this run was rather light, with a maximum accumulated probe pressure of 7 psi in 10 days. Several attempts were made to reduce this activity by increasing the inhibitor injection; however, water-oil emulsion and carryover resulted. Although there was a considerable improvement in fouling, corrosion, and scaling of the equipment, it was still necessary to replace the top section of tubes in each of the three upper atmospheric overhead condenser bundles at the next turnaround inspection. The unit was brought back onstream with an inhibitor injection rate of 6 ppm. The pH of the overhead receiver water was now controlled at 7.0 by ammonia injection.

With the start of ammonia injection, difficulties were experienced at other process units. Ammonia and its compounds were found in all overhead and side streams of the atmospheric fractionating operation at the crude oil unit. The light gasoline naphtha carried the ammonium constituents through the caustic washes and into the copper-sweetening unit. The ammonia caused high consumption of treating chemicals, high copper content in treated gasoline and severe corrosion of lines carrying the treated stocks. The heavy naphtha carried the ammonium constituents into the reactor sections of the reformer, which disturbed catalyst activity by stripping the chloride ions from the catalyst.

Fouling of the preheater section of the reformer was also attributed partly to ammonium salts as well as to oxidizable sulfur and dissolved oxygen. The effect on kerosine was the same as on the light gasoline naphtha because this stream was also copper-sweetened. The effect on the diesel stream was in its quality inasmuch as the ammonium constituents caused deterioration of copper materials normally used in motor injector systems and fuel lines. The settled moisture in rundown and storage tanks resulted in some corrosion of tank bottoms.

This corrosion was very likely the result of dissociation of the ammo-

TABLE 1
Corrosion Rates at Crude Unit Atmospheric & Gasoline Overhead Equipment

12 Months of operation at pH of 6.8-7.5 with NH_3 injection only.	12 Months of operation at pH of 6.8-7.5 with NH_3 + 6 ppm of organic amine inhibitor injection.	27 Months of operation at low pH of 4.0-4.5 with small amount of ammonia injection + amine inhibitor injection rate at 12 ppm.
Carbon Steel		
General Rate.....0.04 ipy Pitting Depth.....0.07 ipy Heavy scale on equipment plus heavy sludge deposits.	Genera. Rate.....0.01 ipy Pitting Depth.....0.03 ipy Light scale on equipment plus light sludge deposits.	General Rate 0.008 to 0.010 ipy Very Mild General Pitting. Very light scale or film.
Inhibited Admiralty		
Severe pitting at condenser inlet only and general heavy attack under sludge deposits at rate of 0.06 ipy. Stress Cracking	Severe pitting at condenser inlet at rate of 0.05 ipy. Moderate attack under sludge at rate of 0.025 ipy. No Cracking	Very mild general overall attack less than 0.01 ipy. No Cracking

nium components into acid and ammonium ions. The ammonia migrated into the hydrocarbon layer, which resulted in a decreased pH of the water layer. No specific effect was observed on the gas-oil streams, even though it is a proven fact that nitrogen affects the activity of fluid cracking catalysts.

The adverse effect of high-pH operation of crude oil overhead receiver waters on other processes, and the continued corrosion problems indicated that studies should be made to determine how the operation could be altered in order to give adequate corrosion protection to the overhead equipment and still prevent ammonia contamination of hydrocarbon streams. The simplest method of eliminating such contamination would be to eliminate ammonia injection. This would then present a problem of corrosion protection unless some means were devised to provide a protective film on the equipment. The method which appeared to be the most logical was to use an amine-type inhibitor at increased dosages. Because it was realized that this type of inhibitor was not too effective against hydrogen chloride attack, electrometric titration curves were established for hydrogen chloride and ammonia neutralization. It was found that the neutralization occurred at a pH of 3.2 to 3.5. It was believed that, by neutralizing the hydrogen chloride with ammonia to a pH of 3.5 to 4.5, the inhibitor would provide the necessary protection against hydrogen sulfide attack.

Experiences at Low pH. The low-pH operation was started, and at this time the pH of reflux accumulator water was maintained at an average level of between 3.5 and 4.5, with an inhibitor injection rate of 12 ppm of total overhead.

At the start of low-pH operation of the overhead equipment, the total crude oil charge to the unit was 36,000 barrels per day. As a check on corrosion rates, test coupons, hydrogen probes and analysis of overhead waters for iron and copper content were used. The corrosion test coupons indicated a rather high initial corrosion attack of clean surfaces, and that once a protective film was established, equipment should be cleaned only to correct fouling conditions. The initial rate of attack, as determined from the first samples removed, was approximately 0.04 inch per year for carbon steel and 0.018 inch per year for admiralty. The rate of attack after six months, however, was well below acceptable levels.

Hydrogen probes, which had been installed at the time blistering damage occurred in the atmospheric column reflux accumulator and distillate receiver, were now checked daily at low-pH operations for any indications of hydrogen activity. Except for an occasional small pressure buildup, the probes remained at zero. These pressure gains were usually noted immediately after operation at a rather low pH (3.7 to 4.1). Although confirming data are lacking, it is also suspected that arsine is a contributor to hydrogen activity.

The unit was inspected at the regularly scheduled turnaround inspection, following nine months of operation at low pH levels of overhead receiver waters. The condition of equipment, from both a corrosion and cleanliness standpoint, was good—actually better than had been anticipated. No equipment required replacement at this time because of corrosion damage.

The following 18 months of operation were completed without any failures or plugging of equipment. During this time, continuous inhibitor injection was started at the rate of 6 ppm to the gasoline fractionator overhead. The pH of reflux accumulator waters was then again slowly lowered to the range of 4.0 to 4.5, and the inhibitor injection rate was maintained at 9 ppm. This resulted in good protection, as shown by low iron and copper contents in receiver waters and no continuous hydrogen probe activity. Early in the spring of 1956 the raw-crude charge rate to the unit was slowly increased to 42,500 barrels per day, and, within a short time, the hydrogen probes indicated a small pressure buildup and would not remain at zero after pressure bleedoff. The inhibitor injection rate was then increased to 15 ppm of total atmospheric overhead; and after approximately three weeks, the probes would again remain at zero pressure after bleedoff as long as the average pH range, as determined by the laboratory, remained at approximately 4.3, but they would show intermittent activity in the pH range of 3.7 to 4.1.

During the 1956 turnaround inspection, following the 18 months' operation at low pH levels, the equipment was again found to be in good condition. The unit was clean and showed a rather light, even protective film.

The establishment of actual corrosion rates of equipment which has been in operation under different conditions and for various periods of time is rather difficult. Figure 1 gives a summary of the relative corosion rates, as nearly as could be determined, for the three different operations with (1) high pH and ammonia, (2) high pH and ammonia plus inhibitor, and (3) low pH and inhibitor.

RESULTS

1. The lower pH minimizes the amonium-salt dissociation which would otherwise contribute to the complex corrosion problems and formation of iron and copper sulfides.

2. It appears that if chlorides are neutralized with ammonia to a pH of 4.0 to 4.5, the inhibitor, at increased dosages, will provide a simple and effective surface film to protect the equipment from attack by hydrogen sulfide or other weak acids.

3. To a large extent, the quantity of inhibitor injection required for corrosion protection depends on velocities and flow rates.

4. When ammonia is injected only for chloride neutralization, ammonia contamination of all hydrocarbon streams is kept at a minimum.

Originally presented before the API Division of Refining Meeting, Philadelphia, May 13, 1957.

About the Speaker

E. A. SCHNAKE graduated from Purdue University with a B.S. degree in chemical engineering, metallurgical option. Since 1946 he has been with Ohio Oil Co., Robinson, Ill., as a design engineer associated with corrosion and metallurgical problems.

Survey Reveals Reformer Corrosion Data

This panel report on a 31 company survey shows the most frequently encountered difficulties related to reformer corrosion.

E. B. Backensto
Socony Mobil Oil Company Incorporated,
Paulsboro, N. J.

A SURVEY of 31 companies, representing experience on all types of commercial catalytic reforming units and desulfurizers which use hydrogen, revealed that the most frequently encountered difficulties related to corrosion were excessive metal loss; heavy scaling of furnace tubes, exchangers, and/or transfer lines; plugging of catalyst beds, and fouling of heater and exchanger tubes. The most widely used methods to combat and/or control corrosion are proper alloying, generally with 18-8 chromium-nickel stainless steel at high temperature; feedstock desulfurization; hydrogen sulfide removal in recycle gas; and aluminizing.

Corrosion Severity. For the purpose of the survey, corrosion was considered serious whenever it or its products interfered with the normal operation of the unit. Of the 27 companies reporting, 21 experienced serious corrosion in at least one of their units. Of the six companies reporting no serious corrosion, one reported that early indications of very rapid corrosion in heater tubes proved to be the result of excessive tube-wall temperatures. Another company reported moderate corrosion during the initial run, confined mostly to heater tubes, where the scale was $\frac{1}{64}$ to $\frac{1}{32}$ inch thick. Two companies reported that pilot-plant operations resulted in high corrosion rates; the results, therefore, were used to select the proper alloys in the commercial units. The remaining two companies had essentially no hydrogen sulfide in their units because the catalyst was not of the platinum type; the sulfur in the charge stock combined with the catalyst and was

Survey Reveals Corrosion Troubles and Remedies

Serious corrosion was reported by these companies . . .

	Number of Companies
Excessive metal loss (above that anticipated)	20
Heavy scaling of furnace tubes, exchangers, and/or transfer lines	18
Plugging of catalyst beds	16
Fouling of heater and exchanger tubes	13
Stress-corrosion cracking of austenitic stainless steel	7
Pitting or condensate-chloride corrosion	6
Hot spots in furnace tubes	3
High-temperature hydrogen attack on carbon-steel reactor internals	3
Carburization	1
Dezincification	1
Fatigue failure due to vibration	1

What they're doing about it . . .

Proper alloying, generally with 18-8 chromium-nickel at high temperatures	13
Feed-stock desulfurization	11
Hydrogen sulfide removal in recycle gas	8
Aluminizing	8
Acid cleaning (to remove scale)	5
Radial flow reactors or mechanical scale catchers	4

released as sulfur dioxide on regeneration.

Serious corrosion was not always found in the first unit put into operation by any one company. Many of the first catalytic reformers handled low sulfur stocks, or a desulfurizer was used for protection of reforming catalyst. Trouble usually arose when reforming severities were increased and/or higher sulfur stocks were charged. Today the various companies are modifying designs of new units in line with their own experience and that of others reported in the literature. In the newest units indications are that these design and operation modifications are successful for controlling sulfidic corrosion.

Initial Preservative Measures. Seven companies reported that no preventive measures were incorporated against high-temperature hydrogen sulfide attack in their catalytic reforming units when first built. Generally, their experience with catalytic cracking and thermal reforming units was used to guide the selection of materials. Low chromium-molybdenum steels were used extensively for high-temperature service and to guard against hydrogen attack. Some 18-8 chromium-nickel steels were used for their high strength properties. One company used feed desulfurization unless the sulfur was low; at the higher sulfur levels, parts of the unit were designed with added corrosion factors.

Of the 21 companies reporting serious corrosion in at least one of their units, 7 had employed some stainless-steel alloying, 5 used feed desulfurizers, 4 used hydrogen sulfide removal systems on the recycle gas and 2 used aluminizing. Several companies used combinations of these preventive measures. The serious corrosion, however, did not occur in locations where suitable preventive measures were used. The type of serious corrosion was not always the same, it was not always sulfidic in nature, and experiences were not directly comparable for similar units. One company's summary stated that moderate to severe corrosion was found in three units, while the fourth showed slight to moderate corrosion. In this case, the lesser trouble was believed by them to be due to a much cleaner charge stock and somewhat different operating conditions. One company reported no sulfide corrosion, but serious condensate corrosion from chlorides.

Metal Loss and Scaling. Data in the current literature on high-temperature hydrogen sulfide corrosion adequately illustrate the degree of metal loss and scaling which can be expected under various catalytic reforming conditions. In one case cited for the panel, 500 pounds of scale was removed from one fixed-bed reactor after eight weeks of operation.

It was mentioned that the scale formed is too porous to be inhibitive as in thermal cracking where coke plugs the pores of the scale. The scale formed is chiefly iron monosulfide. The use of X-ray fluorescent techniques shows that, initially, chromium tends to concentrate in the scale at the metal surface.

Not all scaling difficulties, however, are explained by the available information. One company reported extensive scaling on the feed side of 5 percent chromium-molybdenum preheat exchanger tubes. This was very similar to iron sulfide scale found at high temperatures in a hydrogen sulfide-hydrogen atmosphere, except that no hydrogen was added to the feed stream. A theory was advanced by the company that hydrogen from the reactor effluent stream inside the tube diffuses through the tube walls. However, the panel believes that it is more likely that the hydrogen present was either dissolved in the feed or produced by thermal cracking.

Plugging due to scale accumulation in the catalyst necessitating lowering of the unit throughput. Plugging which resulted from flaking scale was the indirect cause of a damaging fire in one case.

Fouling. Fouling of exchanger tubes has been particularly troublesome in many installations. Fouling was prevalent in exchanger bundles before naphtha pretreaters, in the vapor phase or at the vapor point, and was usually due to sulfur and oxygen compounds. The fouling may be accompanied by some corrosion, since in one case (< 0.06 percent by weight of sulfur, at 400 F. to 500 F., with the hydrogen present) several leakes were found on testing. However, this was after the fouled bundles were cleaned by acid washing, and the panel believes that this may have been the real cause of failure.

Fouling may occur on the fresh feed or shell side of the exchangers where no hydrogen is present. This may be in the form of a relatively loose layer of scale, plus a carbon buildup on the outside of the tubes. Remedies that have been tried, but not always successfully, usually center around the elimination of oxygen in the storage system. Examples include gas-blanket storage tanks, use of floating-roof tanks, direct "rundown" of charge to unit, and installation of deaerator towers. Other methods include use of inhibitors, spare bundles, duplicate exchangers and bypass connection, and replacement of carbon steel and low chromium steels with 18-8 chromium-nickel steels.

Stainless-Steel Failures. After 1½ years of operation, eight stainless-steel furnace tubes (Type 304, original thickness 0.31 inch) in one unit were retired because they were pitted below the minimum wall thickness. Two of these were coked solidly and were

About the Speaker

E. B. BACKENSTO, senior engineer with Socony Mobil Laboratories, has held various research positions since he joined the company at Paulsboro, N. J. in 1943. During that time he has served as a group leader in charge of light product refining and treating, and in reforming catalyst development. Currently he is engaged in corrosion studies. Backsento is a graduate of Lehigh University with a B.S. degree in chemical engineering.

deeply pitted to a minimum wall thickness of 0.14 inch. This pitting was not believed to be the result of sulfur corrosion. The operating temperature was 1120 F. to 1175 F. but may have been abnormally high at times. The only microstructural defect observed was carburization of all inside surfaces, 0.002 to 0.010 inch deep, but the degree of carburization could not be correalted with the severity of pitting.

Cracking of austenitic welds in both ferritic and austenitic furnace tubes has been reported. Here the important factors were reported to be welding quality, inherent microfissuring of austenitic weld deposit and possible stress-corrosion cracking from the formation of polythionic acids from iron sulfide scale and moisture during turnarounds. To prevent this type of failure, increased efforts are made to insure sound welds by radiographic and dye-penetrant examination, hydrostatic test, and use of welding rods containing a small amount of ferrite. Also, before the furnace coils are opened for a down-period, they are filled with a 5 percent solution of sodium carbonate to neutralize any acids which may be formed.

Stress-corrosion cracking has been reported in Type 304 stainless steel in parts other than furnaces. Stress from bending and corrosion from hydrogen sulfide were reported to have caused a tube operated at 1100 F. and 265 pounds per square inch gage to crack at a U-bend. Stress relieving (conditions not given) is now recommended. A Type 304 nozzle cracked in similar service and was replaced with 4 to 6 percent chromium steel. The panel knows of no generally recognized case of stress-corrosion cracking at high temperature; the panel believes these failures were probably the result of corrosion during a shutdown.

Trouble in the nature of stress corrosion, hydrogen embrittlement, or corrosion fatigue has been experienced in relief valves and compressors handling hydrogen sulfide. This has been attributed by one company to the action of hydrogen sulfide upon metals subjected to frequent changes in tension or compression. The failures were very rapid—in a matter of hours in some cases—with all types of ferrous material including stainless steel. The company claims that this difficulty can be overcome by the use of nickel-base, 13% cr., 6% fe alloy, "K" monel, or aluminized carbon steel, preferred in that order.

Intergranular Attack. A Type 304 stainless-steel thermowell in a furnace outlet line was found badly corroded under the following operating conditions, which included one five-minute period of steam-air decoking: temperature, 1180 F. to 1200 F.; hydrogen content, 60 percent. Examination showed intergranular attack, probably from sulfur compounds, with subsequent spalling; the hottest part was carburized and pitted.

In Hydrofiner service, some intergranular attack of Type 304 stainless steel has occurred and has caused pipework failures. The source of this information believes Type 304 to be susceptible to intergranular attack by hydrogen sulfide above 650 F. No intergranular attack by hydrogen sulfide has been reported on 18-8 materials stabilized by columbium or titanium. An unpublished German report states that these stabilized 18-8 materials form a protective film of iron sulfide scale which is very adherent and should not be removed during shutdown periods. Intergranular cracking adjacent to welds in Type 304 tubing in catalytic reforming service has also been reported in the literature.

Chloride Corrosion. Reports have been received that corrosion in shell and outlet piping of final reactor effluent coolers is believed to be attributable to hydrochloric acid produced from alternate injection of chloride and water into reactors to maintain catalyst activity. Chloride corrosion, aggravated by temperature variation and turbulence, also caused failures at the junction of liquid lines from hot and cold receivers. This was eliminated by rearrangement of piping for better flow conditions, plus alloy lining of the junction areas (the type of alloy was not given).

Several reports state that exchanger tubes, particularly after feed pretreaters, have been plugged, as much as 80 percent, with ammonium chloride. In another instance it was believed that stress-corrosion cracking of antimonial admiralty exchanger tubes and compressor valves was promoted by ammonium chloride. Where this trouble developed, the stripper, return towers, and condensers are now water-washed until all blue color (indicative of copper compounds) is gone whenever they shut down.

Hot-Spot Failures. One hot-spot rupture resulted in an explosion and fire damage. Typical hot-spot splits, mostly on "roof" and outlet tubes, have been cited. In some cases faulty thermocouple installations may have permitted excessive metal temperatures. In one unit this type of failure on 5 percent chromium heater tubes was reported to be due to a thick (¼ inch) layer of scale, sometimes with ⅛ inch of carbon over the scale. Acid cleaning alone did not eliminate these deposits. Now steam-air decoking is used prior to acid cleaning.

Moisture. For one type of design, after a year of operation, 2 of 6 desulfurization units had serious scaling trouble. The total sulfur in the charge to all these units was below 0.1 percent by weight; all contained chloride ion. Scaling was worst when the naphtha was saturated with water and least when the naphtha was dry. In the four units where no serious trouble occurred, the charge stocks contained 150 to 180 parts per million of water, but no free water. (The charge to the reformer reactor section is considered dry at 20 ppm of water.)

Important Factors. There was unanimous agreement that the most important factors in catalytic reformer corrosion were the concentration of hydrogen sulfide in a hydrogen atmosphere and temperature. Three companies were of the opinion that when hydrogen chloride was present, it contributed to the severity of the corrosion. Oxygen content of the feed and the alternating from reducing to oxidizing (during regeneration) conditions were considered important factors by three companies. The following secondary factors were mentioned: pressure, geometry of the corroding

surface; ammonium chloride, and sulfur, nitrogen, water, and arsenic content of the feed.

Methods for Control of Corrosion. There appears to be a general opinion that the combination of sulfur in the charge (calculated as hydrogen sulfide) and that in the recycle gas should be below 0.006 to 0.01 percent by volume to minimize corrosion in low and intermediate alloy-steel furnace tubes and hot transfer lines. Some companies reported, however, that 0.015 to 0.02 percent by volume of hydrogen sulfide did not result in serious corrosion. There have been indications that the type of sulfur in the charge to desulfurizers might have an effect on corrosion.

The difficulty of removing scale from corroded metal was mentioned by several people. Even though apparently adherent, such scale offers little protection against further corrosion and tends to flake when the unit goes back onstream. Sandblasting of scale from reactor vapor outlet screens and hydroblasting of exchanger bundles are commonly used. The acid cleaning generally employed appears to be the inhibited-hydrochloric acid type, with good success reported. Oxalic acid cleaning may only loosen scale and do very little dissolving.

Steel, coated with aluminum by calorizing, hot dipping, or spraying, has been shown to be very effective experimentally, but is not always considered a satisfactory means from a practical standpoint in view of the tendency to flake and the difficulty of welding. Nonetheless, considerable aluminized steel is now being used and tested in commercial.

18-8 Chromium-Nickel Steel. When resistance to sulfide corrosion is necessary, the trend is toward more extensive use of 18-8 chromium-nickel steels, particularly in desulfurizing equipment.

In one Autofiner the transfer lines were fabricated from 4-, 6-, and 8-inch-diameter pipe. The 4-inch pipe was drawn tube, and the 6- and 8-inch pipes were formed from rolled plate by shaping and longitudinal seam welding. All the pipe material was titanium-stabilized 18-8 chromium-nickel, and the electrodes were columbium-stabilized 18-8. The weld joints were not heat-treated or inspected by X-ray after welding. Apart from one crack in a flange-to-pipe seal weld, attributed to poor welding technique, no corrosion or cracking troubles occurred on the 18-8 stainless steel after four years of operation. It has been concluded from a thorough examination (visual, liquid penetrant, and X-ray) that the welded joints and parent metal of the stainless-steel transfer lines are sound and have not suffered any deterioration during the four years of Autofining operation which included 35 regenerations. The pipework was considered suitable, in its present condition, for a further indefinite period of service.

Original presentation at API Division of Refining, Philadelphia, May 13, 1957.

ACKNOWLEDGMENT

The panel wishes to thank the management of the contributing companies for allowing their representatives to assist in this activity. We are grateful to C. M. Schillmoller, a former member of the panel, for the assistance and continued interest in this work. Members of the panel include E. B. Backensto (chairman); W. A. McCarthy, Phillips Petroleum Company, Bartlesville; Cecil Phillips, Jr., Humbe Oil & Refining Company, Baytown, Texas, and C. H. Samans, Standard Oil Company (Indiana), Whiting, Ind.

More About Corrosion

Platformer Corrosion Is Low: Corrosion has not been a serious problem in the operation of Platforming units. This is attributed to the low H_2S level in the recycle gas. The low level is maintained either by use of low sulphur charge stocks, amine scrubbing of recycle gas, or desulphurizing the charge stock by Unifining. It is believed that the continuous operation, which is a feature of these units, plays an important part in the minimizing corrosion rates as compared to alternate processing and regenerating conditions.

The paper presents some plant corrosion data, over relatively long periods, on heater tubes of different alloys, and in different sulphur environments, including the effect of acidizing.

Comparisons of plant results with laboratory corrosion data, often show significant differences because of trace quantities of material which do not accumulate in laboratory work.

("Some Typical Cases of Corrosion in U.O.P. Platforming Units," D. J. Bergman and S. A. Bjorkman, Universal Oil Products Company, Des Plaines, Ill.)

Corrosion Control In Ultraformers: Control of sulfidic corrosion in Ultraformers is desirable for two reasons. It increases equipment life and prevents a build-up of pressure drop across the catalyst bed caused by dislodged corrosion products. Data on the corrosivity of hydrogen sulfide-bearing streams have been obtained, in laboratory and in plant tests, as a function of hydrogen content, temperature, and pressure. The effect of chromium content of the steel also has been studied. The correlations obtained in this work permit an approximate prediction of corrosion rates under unit operating conditions. Experience shows that satisfactory operation from a corrosion viewpoint can be secured by several methods. It may be accomplished by the proper control of hydrogen sulfide; hydrogen ratio of the vapor stream, or by the separation of naphtha and hydrogen-bearing streams. It may be obtained through selection of suitable alloys and/or coatings, and by the use of inhibitors.

("Corrosion Control in Ultraformers," Andrew Dravnieks and Carl H. Samans, Standard Oil Company (Indiana), Whiting, Ind.)

Hydrogen Attacks Reformer Steel: Cracks in reactors force reformers to shut down. Hydrogen at high temperatures and pressures is the culprit. Protection given by insulating lining is not enough. Metal temperatures determine the extent and location of damage.

("Hydrogen Attack of Steel in Reformer Service," A. R. Ciuffreda and Warren D. Rowland, Esso Research and Engineering Company, Linden, New Jersey.)

Gas Chromatography Steps Out

New methods of analysis are shown in these abstracts from the Analytical Research Session.

THERE IS an increasing need for a reliable and yet not too time-consuming method for the analysis of saturated hydrocarbons, naphthenes and paraffins. Long realizing this need, the American Petroleum Institute's Committee on Analytical Research canvassed the available methods; these include catalytic dehydrogenation (and determination of aromatics formed), correlations with refractive index and density, and mass and infrared spectrometry. The extent and reliability of the information furnished varies with the method exployed. It also depends upon the effort and time one considers worth devoting to the task. This is very much the case with spectrometry, which yields by far the most detailed information; it is quite time-consuming, however, because it requires a rather good fractional distillation.

This paper describes the application of the new analytical tool, gas chromatography (GC) to this problem. The material analyzed was the whole saturates portion of a reformer charge stock, containing chiefly C_6 and C_7 compounds. It was recently analyzed cooperatively by 12 laboratories, employing the methods mentioned. It was found that all but one of its 25 C_5 to C_7 components could be detected and measured. Certain C_8 compounds caused slight interference, which could be corrected for by mass spectrometry of three gas chromatographic cuts and which also yielded the missing component. The average deviation from the grand average results of the API cooperative testing was 0.3 percent. The accuracy of the GC method, established by analysis of a synthetic blend simulating the real distillate, was about 0.1 percent. This is better than obtained by the other methods. The GC method is also considerably faster, requiring 12 to 16 hours for the complete analysis and proportionately less when detailed information is not essential.

("Determination of Five- to Seven-Carbon Saturates by Gas Chromatography," F. T. Eggertsen & Sigurd Groennings, Shell Development Company, Emeryville, Calif.)

Soap and Oil in Greases. Conventional methods for determining soap and oil in lubricating greases are slow and tedious. A simple chromatographic method has been developed for the determination of soap and oil in soap-thickened greases made from petroleum, silicone and ester oils. Four to six samples are analyzed in eight hours. Precision and accuracy of the method are equivalent to those of the ASTM extraction method. Interference from minor components of the greases are negligible.

("Rapid Chromatographic Analysis of Soap-Thickened Lubricating Greases," George W. Powers, Jr., and Frank J. Piehl, Standard Oil Company (Indiana), Whiting, Ind.)

New Analysis Approach: Classically, statistical analysis of data is performed on an arbitrary number once the experiment has terminated. The question of the number of data required to validate a hypothesis is not answered by the classical method of statistical hypothesis testing.

A new approach to this problem, called "Sequential Analysis," has evolved as a result of researches on problems of wartime operations. A sequential test which has been found to be particularly useful is Wald's "Sequential Probability Ratio Test." This test shows how to estimate, in advance of an experiment, the number of observations that will be required, on an average, to either validate or invalidate a proposed hypothesis at an arbitrary level of statistical significance.

("The Sequential Probability Ratio Test as a Novel Statistical Procedure in Analytical Chemistry," Anthony F. Bartholomay and Bert L. Vallee, Harvard Medical School, Boston, Mass.)

Oil in Waste Effluents: Analytical procedures for the determination of oil pollution in refinery effluent waters have been a 25-year battle for API. Precise analytical methods are required to measure the oil that is present in the effluent and to determine the efficiency of the separators.

Other sessions covered here

206 Training Session
207 Air Pollution
207 Instrumentation
208 Electrical Equipment

Through its research studies, the American Petroleum Institute's Committee on Analytical Research has made available to petroleum refiners a number of improved methods of analysis for this purpose.

This paper deals with a cooperative study made by a group of eight petroleum laboratories of three of these methods. The results indicate that the best over-all method involves the use of an infrared analyzer. The technique can be used for oil concentration down to 1 ppm (.0001 percent).

("Determination of Oil in Refinery Effluent Waters," J. B. Rather, Jr., Socony Mobil Oil Company, Brooklyn, N. Y.)

Quicker Gum Analysis: Socony Mobil Research and Development Laboratory is increasing its use of automation in chemical analysis. It has been found that an instrument, widely used in the petroleum industry to measure the amount of water in gasoline, can now be used to analyze

for unsaturated or potential gum-forming components as well. The device not only gives values more rapidly than the former methods, but gives them more accurately.

("Influence of Olefin Structure on Bromine Number by Various Analytical Methods," E. H. Unger, Socony Mobil Oil Company, Paulsboro, N. J.)

Trace Metals: Vanadium, nickel and iron can be measured in concentrations as low as 5 ppm with this spectrochemical method. The method may be used on samples as small as 10 grams, frequently a limiting factor in pilot plant or bench scale studies. Application will help the operation of crude oil distillation and catalytic cracking of gas oils.

("A Wet-Ash Spectrochemical Method for the Determination of Trace Metals in Petroleum Fractions," John Hansen and C. R. Hodgkins, Esso Research and Engineering Company, Linden, N.J.)

Zinc in Lube Oils: The reaction of dithizone with various heavy metals was studied in benzene-methyl alcohol solution. It was found that the reaction can be made the basis of photometric titrations of some of these metals. A rapid method for the determination of zinc in lubricating oil was developed in which less than 0.1 percent of zinc in oils can be determined with an accuracy of 1 to 2 percent.

("The Nonaqueous Titration of Zinc —A Rapid Method for Zinc in Lubricating Oils," T. L. Marple, G. Matsuyama and L. W. Burdett, Union Oil Company of California, Brea, Calif.)

Water in Gasoline: An accurate method for determining part-per-million quantities of water in reformer charge stocks and products is of value because of the possible deactivation of reforming catalyst by water. A Karl Fischer electrometric end point method is described which is applicable over the range of 2 to 300 ppm water.

A procedure for obtaining uncontaminated samples using specially dried sample bottles is given.

("Determination of Traces of Water in Hydrocarbons in the Gasoline Boiling Range—Sample Handling and Interferences," J. West Loveland and Thomas B. Webster, Sun Oil Company, Marcus Hook, Pa.; Charles P. Hablitzel and George W. Reed, Sun Oil Company, Toledo, Ohio.)

Sulfur in Petroleum: Existing analytical procedures for determining the amounts of each type of sulfur compound generally leave a substantial proportion of the sulfur in the crude unidentified. A polarographic procedure has been developed which, coupled with fractionation techniques, permits determination of thiophenes and aromatic sulfides. These two types of compounds together with aliphatic sulfides comprise the major proportion of sulfur found in crude. Using this procedure and the acceptable procedures for other sulfur types, substantially all of the sulfur in many crude oils may be determined.

("Polarographic Estimation of Thiophenes and Aromatic Sulfides in Petroleum and Its Fractions," Harry V. Drushel and James F. Miller, Mellon Institute of Industrial Research, Pittsburgh, Pa.)

Insecticide Analysis: This paper describes some of the methods used at the British Petroleum Research Station, Sunbury-on-Thames, England, for the assessment and analysis of insecticides. It deals with the biological methods employed using house flies and flour beetles; provides details of the infrared absorption technique used for the anlaysis of insecticides; and gives two examples of the combined methods in operation.

("The Analysis and Biological Assessment of Petroleum-Based Insecticides," A. D. Harford, E. Thorton, and N. G. McTaggart, The British Petroleum Company, Ltd., Middlesex, England.)

Trace Hydrocarbons: It is sometime desirable to estimate the quantity of organic vapors in the atmosphere. However, the low concentration of these vapors in air makes this task difficult. The authors have developed a method for isolating these vapors and concentrating them so that they may be analyzed by standard techniques. In this method a large volume of air is passed through a glass vessel which is immersed in liquid nitrogen at —320 F. At this temperature organic vapors in the air passing through the vessel will freeze out of the air and concentrate on the walls of the vessel. Water vapor and carbon dioxide, normally present in the air, will also freeze out on the walls.

To remove these two contaminants the vapors collected in the vessel are further treated in a high vacuum apparatus where the carbon dioxide and water vapor are absorbed on special chemicals. The organic vapors, concentrated and separated from other gases in the manner described, are then passed into a mass spectrograph for analysis.

("Determination of Trace Quantities of Hydrocarbons in the Atmosphere," E. R. Quiram and W. F. Biller, Esso Research and Engineering Company, Linden, N. J.)

Nitric Oxide in Tail Gases: The toxic nature and apparent involvement of nitrogen oxides in producing "smog" has necessitated the development of simple and accurate methods capable of measuring low concentration of nitric oxide and nitrogen dioxide. The described instrumental technique is applicable to the determination of these oxides in one source of these air pollutants—nitric acid plant tail gases. The procedure is simple, adaptable to routine control operations, and provides reliable values for either nitric oxide or nitrogen dioxide (or the sum of the two) at concentration levels of less than ten parts per million in about two hours.

("Spectrophotometric Determination of Nitric Oxide or Nitrogen Dioxide in Nitric Acid Plant Tail Gas," Francis J. O'Hara and Orville N. Hinsvark, The Girdler Company, Louisville, Ky.)

Training Session — Needed: A new managerial philosophy

THE RISE in the power of unions, evolution of mass markets, mass production and the massive corporation have created a growing need to focus more attention on the problems of human relations and personnel management. Result: Management and supervisory development programs have been directed principally to techniques of supervision and motivation, and to a variety of new approaches to the improvement of administrative practices.

Today, the manager's problem is one of maintaining enough acceptance

of his authority to get the job done without destroying the individual's sense of responsibility for making his unique contribution and relating himself in a meaningful way to the enterprise. This is the problem of keeping bigness small and meaningful. There are a number of approaches to this objective, but in the final analysis this is a matter of the soundness of the manager's own objectives and the spiritual values by which he lives.

("Search for a Managerial Philosophy —A Basic Training Need," O. A. Ohmann, The Standard Oil Co. (Ohio), Cleveland, Ohio.)

How to Handle Problem Personnel: A small group of employes in modern industry fails to meet the standards of performance established as normal by the majority. Maintenance of group morale and optimal productivity demands that the supervisor identify members of this minority group and do everything possible to improve their performance. Some members of the group have inadequate personalities, others have recognized medical or psychiatric difficulties.

As a staff member, the doctor in industry can help in defining into which area a given problem case fits. Where medical or psychiatric help has a reasonable chance of success, he can guide the individual toward obtaining it. He can also play an educational role in helping both supervisors and employes understand and handle these problems more intelligently.

("Recognition and Adjustment of Problem Cases Among Refinery Personnel," John J. Thorpe, Esso Standard Oil Co., New York, N. Y.)

Air Pollution Session — Gases that damage flora

PRINCIPAL ATMOSPHERIC contaminants responsible for plant damage are dusts, acid aerosols, and gases such as sulfur dioxide, halogens, hydrogen sulfide, ammonia, and carbon monoxide. Gases usually cause the most damage.

Sulfur dioxide was first recognized as causing damage to vegetation. To prevent damage, concentrations of sulfur dioxide must be below 0.1 percent.

Fluorine is another gas that causes considerable damage. Although it is selective and affects pine and gladiolus to a greater extent than other plants. Fluorine has harmful effects on farm animals when fluorine in their feed stuffs reach certain levels.

The other halogens and hydrogen sulfide, ammonia, and carbon monoxide cause little significant damage because of their limited concentration.

The principal plant-damaging oxidant has not been specifically identified but it is believed to be an oxidized organic which causes damage. Although aldehydes and organic acids do not themselves cause typical plant damage, some unknown intermediate reaction products of olefins and ozone do.

("Damage to Vegetation from Polluted Atmospheres," John T. Middleton, Ellis F. Darley, and Robert F. Brewer, University of California, Riverside, Calif.)

Auto Exhaust Studies: A survey of a three-year study on automobile exhaust emissions, conducted by the Vehicle Combustion Products Subcommittee of the Automobile Manufacturers Association, shows that good progress has been made in the analytical field, although a continuous method for the oxides of nitrogen has not as yet been developed; that analysis for individual hydrocarbons still requires considerable study; and that for the problem of daily reduction from the various analytical methods, some type of integrator will probably be required.

The work of the Traffic Survey Group, whose information is to be correlated with that of the Field Survey Panel, is nearly completed. The groups which are studying devices which might reduce exhaust emissions reached the conclusion that, among the induction-system devices, those which maintain the throttle in a slightly open position are the most practical. As exhaust-system devices, afterburner and catalytic afterburner show promise for organics reduction.

("Automobile Exhaust Gas—The Program of the Automobile Industry," C. M. Heinen, Chrysler Corporation, Detroit.)

Chemistry of the Atmosphere: Over two years of study using the long-path-infrared spectroscope has shown that the concentrations of nitric oxide and nitrogen dioxide are quite low in smog. However, new organic nitrogen compounds, i.e., peroxyacyle nitrite, as well as ozone have been found as predicted.

Infrared analysis of the products of reactions of ozone with various olefins at low concentration shows that the products identified include aldedydes, carbon monoxide, carbon dioxide and water. Work in this field with higher olefins will continue.

("Further Developments in the Chemistry of the Atmosphere," W. E. Scott, E. R. Stephens, P. L. Hanst and R. C. Doerr, Franklin Institute, Philadelphia.)

Instrumentation Session — Logging at Delaware refinery

WIDESPREAD USE of data logging, scanning, and information systems is made at the new Delaware Flying-A refinery. An examination is made on the reasons for installing the systems, the problems of development and installation, and their acceptance in the refinery.

These systems are most valuable tools and are certain to gain wider acceptance in the future. For the present, it is necessary to educate the operating personnel concerning the many merits of the systems. The success or failure of the systems to be truly ex-

cellent process aids depends on this education program.

("Data Logging, Scanning, and Information Systems Get All-Out Test at New Delaware Flying-A Refinery," James McDonald, Tidewater Oil Co., Delaware City, Del.)

Ohio's Experience: The Standard Oil Company (Ohio) has installed three data logger systems. The first of these was put in operation, in September, 1955, to process data from an ammonia-nitric acid-urea plant. The second, installed in February, 1956, records process variables for two pilot plants. The third, in operation since July on a regenerative type catalytic reformer, functions as an off-normal temperature alarm and point-out system. Two of the data loggers have performed below expectation.

Each data logger installation has been examined with relation to philosophy and justification, results expected vs. realized, and operational problems. From this study have come recommendations as to how to obtain better service factors from such equipment.

("The Case History of Three Data-Logging Systems," Emil E. Ebner, Jr., The Standard Oil Co. (Ohio), Cleveland.)

Esso's Size-Up: Automatic data logging has been in service in the Bayway Refinery of Esso Standard Oil Company for about 18 months. From this experience, it is possible to foresee the possibilities for this type of equipment.

The equipment has a high service factor, is accurate enough to be used for accounting, and relieves some of the burden from operating personnel. The savings which have occurred because of this installation are not as large as were expected. Furthermore, the installation can not be justified for use on all units.

Plans are being made to couple the logger with an automatic computer. If this combination proves out, it may be justified to achieve better process control.

("A User's Appraisal of Automatic Data Logging," E. C. MacMullan, Esso Standard Oil Company, Linden, N. J.)

Radioisotope Uses: Radioisotopes are a convenient source of many types of radiation that can be used in analytical and control instrumentation. These are alpha- and beta-particles, gamma rays and X-rays. The basic principles relevant to the application of these radiations and a number of examples of radioisotope instrumentation actually being used in the petroleum and petrochemical industries has been outlined. Emphasis is on the principles involved, so that the possibilities of extension into new and untried applications will become clear.

("Radioisotopes in Instrumentation," John W. Otvos, Shell Development Co., Emeryville, Calif.)

Safety Needed: Electric and electronic instruments are being used more frequently in the industry for measurement and control of the many complex process operations. Many of these processes involve flammable atmospheres where the use of electrical elements may cause explosions. It is essential then to know the factors which constitute an explosion hazard.

Existing literature report some of the limits within which safe operations of electrical equipment may be obtained. It may be concluded that considerations of only voltage or current conditions of a circuit are poor ways to determine whether a spark can start a fire. More important factors are the induction and capacitance of the circuit. Also the characteristics of the flammable gas mixture must be considered when evaluating the limits of safe operating conditions.

("Intrinsic Safety in Instrument and Electrical Circuits," Lee E. Cuckler, Robertshaw-Fulton Controls Company, Philadelphia.)

Electrical Equipment Session — Oil or oil-less gear?

IT IS ESTIMATED that 10,000 motor-starting devices will be installed in U. S.'s petroleum refineries in 1957. Some of this equipment will be of oil immersed designs, some will be oil-less. To pick the right type, designs must be evaluated in relation to the problems of hazardous atmospheres, corrosion, reliability, maintenance, installation, and cost.

The unification of engineering thought in this equipment controversy would go far to help both the refinery engineer and his counterpart in the electrical manufacturing industry. Co-operative effort in this direction could well result in fewer designs and consequently lower over-all cost.

("Oil Immersed or Oil-less Electric Switching Equipment for Refinery Application?", L. T. Ellis and W. R. Morton, General Electric Co., Schenectady, N. Y.)

Application of Mineral-Insulated Cable: This paper deals basically with the practical aspects of mineral-insulated metallic-sheathed cable. It includes the components of the cable, manufacturing procedures, application-design considerations, and installation techniques. As compared with conventional cables employing organic materials, the unique features of the cable and the new principles of manufacture are fully reviewed. Special emphasis is placed on the suitability of the cable for general use of low voltage wiring systems; and, in addition, its ability to safely withstand operating conditions that would be destructive to other types of cable.

("The Manufacture and Application of Mineral-Insulated Metallic-Sheathed Cable", W. J. Richard, General Cable Corp., Perth Amboy, N. J.)

Design of Electrical Controls: To design low (600 volts and below) and high (2300 to 5000) voltage motor controls, these questions need to be studied:

1. What equipment is available
2. What it appears that the petroleum industry would like.
3. What is possible now.
4. What is needed in the way of design standards.
5. What are the possible approaches to the problem.

The author analyzes these questions to arrive at the best approach for control equipment.

(Possible Approaches to the Design of Control Equipment for Class I, Division 2 Locations," H. A. Wright, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.)

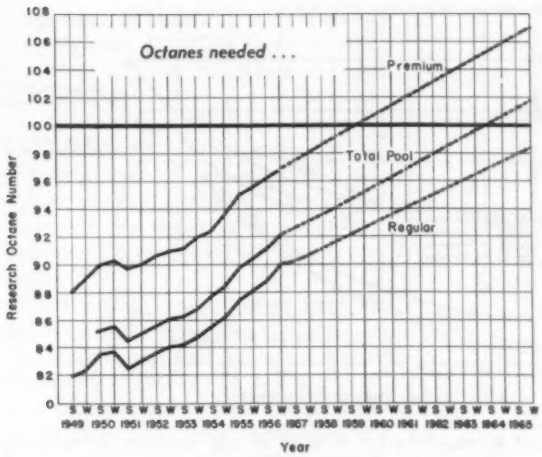


FIGURE 1—Total gasoline pool may reach 100 octane by 1964.

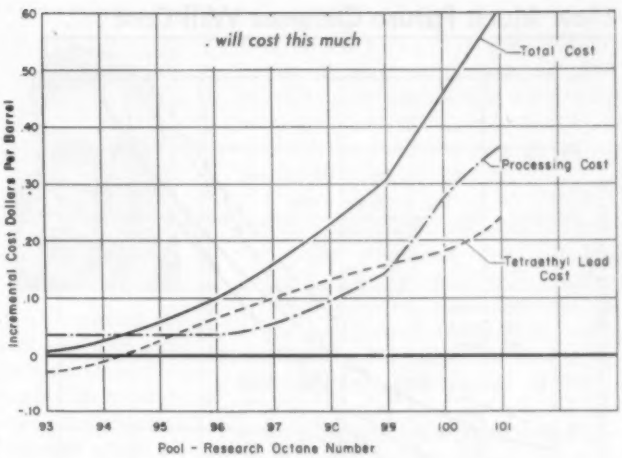


FIGURE 2—How cost components compare in an optimum study.

How Much Future Octanes Will Cost

To meet octane increases, this hypothetical refinery can make an attractive profit by adding processes in this order.

S. W. Curry
Universal Oil Products Company
Des Plaines, Ill.

THE TOTAL average pool motor gasoline produced and consumed in the United States in 1956 was about 92.2 Research octane number. The total pool gasoline may be expected to reach 100 Research octane number by about 1964 (Figure 1). How the present pool can be stepped up to 101 octane and at what cost is described in the example taken here.

As a base case, we have assumed a 20,000 B/SD refinery operating on moderately good Illinois Basin crude oil of the typical analysis shown in Table 1.

This hypothetical refinery includes all off battery limits facilities and the following process units:

- Crude Distillation
- Vacuum Distillation
- Fluid Catalytic Cracking
- Gas Recovery
- Solid Phosphoric Acid Polymerization
- Unifining
- Platforming

Because of our familiarity with UOP processes, they are used in the example. This combination of processes will produce a pool gasoline in the quantities and qualities shown in Table 2.

This hypothetical refinery is capable of producing 93 Research octane number pool gasoline with 0.7 ml. TEL per gallon, at a total lead cost of 7.4 cents per barrel. Based on today's prices, this gasoline is worth $5.04 per barrel FOB Gulf or, exclusive of lead content, $4.96 per barrel.

This refinery, with total pool gasoline of 93 Research octane number, will be considered as the base case. In this case, as with all subsequent evaluations, a pool gasoline of 10 pounds RVP is produced. The calculations include normal costs experienced in the Gulf Coast area for utilities, labor, maintenance, taxes and insurance and a 10 percent amortization factor on all incremental capital investments for equipment added as the study progresses.

TABLE 1

Crude Charge Analysis for Hypothetical Refinery

Gravity, °API at 60 F	36.8
Specific Gravity at 60 F	0.8408
Total Sulfur, Percent	0.24
Reid Vapor Pressure, Lbs.	5.8
100 ml. Distillation, Type:	
I.B.P. F	126
10 Percent	222
30 Percent	384
50 Percent	558
70 Percent	704
90 Percent	744
E. P., F	760+
Percent Recovered	96.5

First Octane by Platforming and Alkylation. When it is desired to increase the pool octane rating at this refinery from the assumed level of 93 Research to 94, by increasing Platforming severity alone, we find an increased cost of 4.6 cents per barrel. However, if we increase Platforming severity and also add HF Alkylation, the incremental cost of raising the octane rating of the final pool gasoline to 94 Research is only 2.3 cents per barrel.

Figure 3 shows this desirability of combining Platformate and alkylate with the other gasoline components, and increasing concentrations of TEL, to obtain pool octane numbers of 94 Research and above. In all succeeding cases, alkylation is included in the processing scheme. The quality of the alkylate is assumed to remain constant at 94.0 Research octane number, clear.

How Much Future Octanes Will Cost . . .

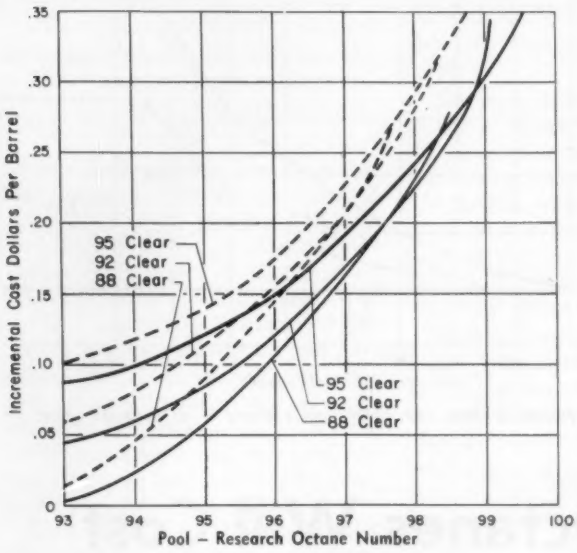


FIGURE 3 (left)—Platforming cost (broken lines) vs. Platforming plus alkylation cost (solid lines): It's cheaper to use a combination approach.

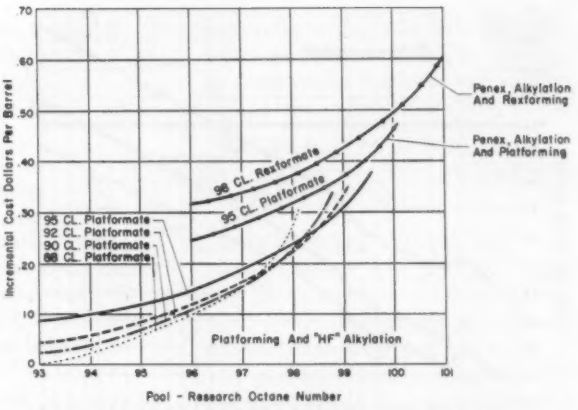


FIGURE 4 (above)—What it costs to add processes at increasing octane levels.

TABLE 2—Gasoline Pool to Start With

	B/SD	Vol. %	°API	RVP	F-1 Cl.	F-1 + 3 cc.
FCC 425° F.E.P. Gasoline	3670	38.1	56.0	5.5	92.5	99.0
2 lb. Polymer	610	6.3	60.5	2.0	96.2	99.8
Lt. S.R. Gasoline	1400	14.5	82.0	18.5	77.0	92.0
Platformate	3625	37.6	49.5	5.6	85.4	95.8
Butanes	331	3.5	115.0	60.0	100.0	110.0
Total Gasoline Pool	9636	100.0	57.9	10.0	88.1	97.2

TABLE 3—Final 101 Octane Gasoline Pool

	B/SD	Vol. %	°API	RVP	F-1 Cl.	F-1 + 3 cc.
FCC 425° F.E.P. Gasoline	3670	36.8	56.0	5.5	92.5	99.0
Alkylate	1490	14.9	69.4	2.8	94.0	103.5
Rexformate	3392	34.0	49.8	9.5	98.8	102.8
Isomerate	1029	10.3	87.0	11.5	79.5	95.5
Butanes	403	4.0	115.0	60.0	100.0	110.0
Total Gasoline Pool	9984	100.0	60.3	10.0	93.8	101.0

The economics of adding alkylation are based upon purchasing sufficient outside isobutane, at 9 cents per gallon, to balance the available C_3-C_4 olefins. Normal butane adjustments to the pool vapor pressure have been included at 5 cents per gallon. Also, any shrinkage from the pool volume of the base case has been included at the previously mentioned value of $4.96 per barrel. Further, any excess production of fuel gas is credited at 12 cents per MM Btu's.

Figure 4 illustrates graphically the cost versus octane curves of the various process combinations involved in producing these higher pool octanes.

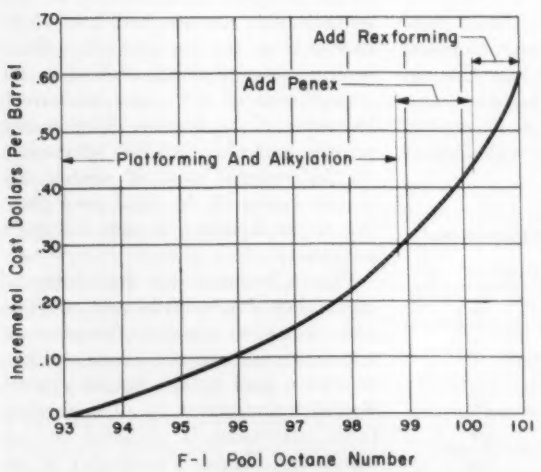


FIGURE 5—To get lowest incremental cost for each pool octane, add processes in this order.

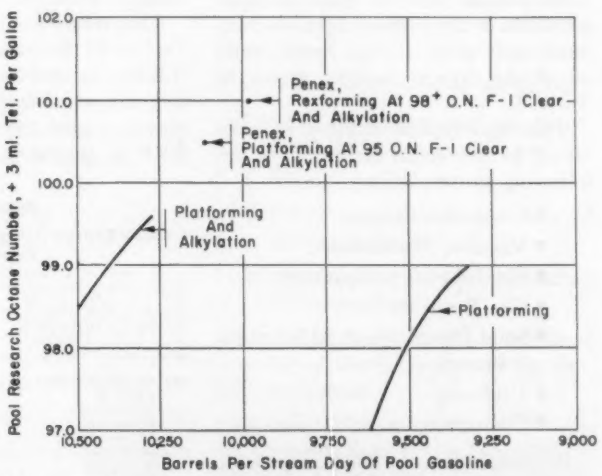


FIGURE 6—Process yields when adding new processes.

Next Step Is Lead. Of several available choices to attain pool octane levels of 95 and 96 Research, the most economical procedure in this case is to increase the lead content of the final gasoline. Specifically, the incremental cost of obtaining 95 pool octane number over the base case is 6.0 cents per barrel. Similarly, the cost for 96 octane pool is 9.7 cents per barrel.

Pool octane ratings higher than 96 Research will require the operation of the Platforming unit at progressively increasing severities. To reach 97 octane requires adding Platformate testing 90 Research, clear, plus alkylate, to the other pool components. Total incremental cost, including additional TEL, is 15.3 cents per barrel.

A pool octane of 98 Research will require Platformate testing 92 Research, clear, alkylate and additional lead. The incremental cost over the base case will be 22.4 cents per barrel.

A 95 Research octane clear Platformate, alkylate and lead will be required to reach a pool octane of 99 Research. Incremental cost over the base case is 30.3 cents per barrel.

Isomerization to Make 100. Further economic evaluations indicate that the least costly route to 100-plus pool octane ratings favor the addition of isomerization.

Adding isomerization of the C_5's and C_6's (Penex, in this case) will involve the separation of isopentane from the mixture, isomerizing the normal C_5 plus all the C_6's as a mixture in a single reactor, depentanizing the reactor liquid product, and recycling depentanizer overhead to the deisopentanizer. In effect, pentane isomerization, therefore, is a recycle operation, whereas the hexane isomerization is once-through. The product will be a combined stream.

The octane rating of the C_5-C_6 isomerate will be 79.5 Research clear (95.5 leaded). The Platformer will be operated to make a 95 Research clear reformate. These, with alkylate and the other gasoline components produced in the refinery, plus TEL, will produce a total pool gasoline rating 100 octane Research. The incremental cost over the base case is 45.5 cents per barrel. Without isomerization, a reformate testing 100 Research octane clear would have been necessary and the incremental cost over the base case would have exceeded 50 cents per barrel.

A pool octane rating of 101 Research is the highest full octane number readily obtainable under this hypothetical processing scheme. At this level we have reached the anticipated U. S. pool octane required in 1965.

Extraction Is Economical at 101. The 101 octane pool gasoline will require all the process units shown for the previous 100 octane case, plus an increase in the severity of the Platforming operation to the level of 98+ Research, clear. At this reforming severity, charging an Illinois Basin naphtha, a Rexformer is indicated as economically preferable to a Platforming operation. We have therefore included Rexforming in this case as a substitute for the Platformer. (In practice the existing Platformer probably would be converted to a Rexformer.) Generally, this would appear to be in order when it becomes necessary to reform to levels in excess of 95 Research octane number, clear. This is not an operational consideration but, as with catalytic reformers in general and less so with Platforming, it is purely a matter of economics.

Figure 5 is the curve of lowest incremental cost for each pool research octane number and the approximate level at which various processes are added to the refining scheme.

Though the example is for a refinery operating on an Illinois Basin type of crude oil, the results would apply with slight modification to the majority of crude oil types and refining schemes. Very large refinery throughputs are not required to justify the additional processing equipment necessary to produce super high octane gasoline.

The major components of the 101 octane pool in our hypothetical refinery are Rexformate testing 98.8 Research, clear; alkylate at 94 Research, clear; isomerate at 79.5 Research, clear, plus the other unfinished gasoline streams as shown in Table 3. The incremental cost over the base case will be 60.2 cents per barrel.

Effect on Yields. Figure 6 demonstrates the effect upon yields when producing high octane numbers by

About the Author

SAM W. CURRY received his B.S. degree in finance and economics from Indiana University in 1943. Following four years service in the Army, he returned to Indiana University where he received his M.S. degree in 1948. Curry then joined Crown Petroleum Corp. where he specialized in refinery economics and coordinated crude and product movement. In 1951 he accepted a position with Universal Oil Products Co. as a sales representative in the Commercial Development department. In June 1953 he was transferred as a sales representative to the Products department and in October 1955 was made the head of the newly-created Market Research and Economics department, the position he now holds.

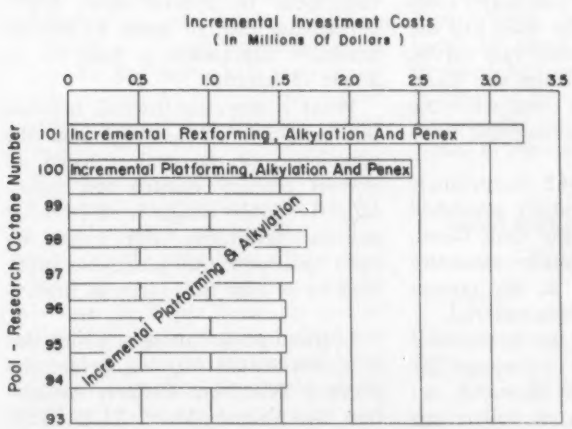


FIGURE 7—What the investment cost is for process equipment to add each octane number to the pool.

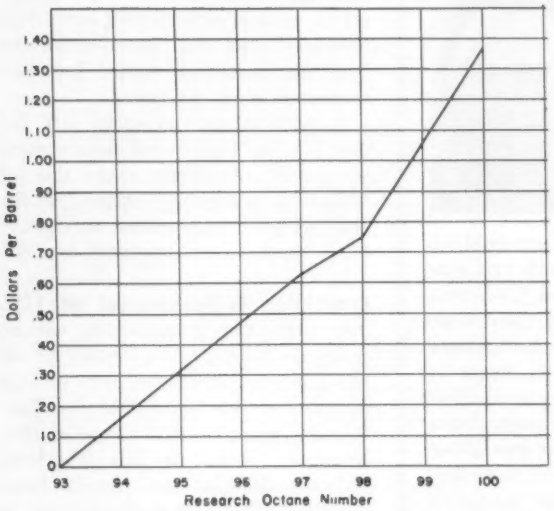


FIGURE 8—Incremental motor gasoline prices above 93 Research (Gulf Coast cargo—lows as of Feb. 14, 1957).

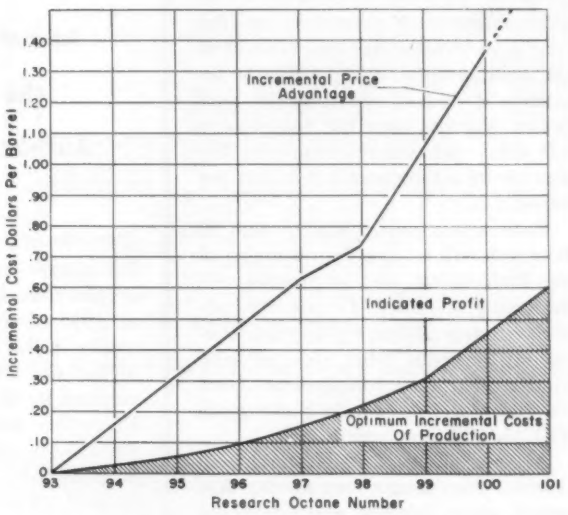


FIGURE 9—Profit margins for incremental octane quality: Equipment can be paid out in 12 months up to 100 octane level.

the various refinery processes which we have considered here. At the present market values for high quality gasolines, any appreciable volume shrinkage is to be viewed with alarm, as it may very well be the highest cost factor to be encountered in octane number improvement. Consequently, the employment of alkylation and isomerization processing, in preference to high severity reforming, is obviously the desirable route from an economic standpoint.

What Capital Is Required. So far we have discussed operating costs but have not stated the capital investment involved in adding HF Alkylation, Penex and Rexforming. Figure 7 shows the estimated incremental capital investment required for process equipment for each additional octane number of the total pool gasoline.

Immediately upon increasing the pool octane number above 93 Research, the HF Alkylation unit costing about $1,550,000 is indicated. It is capable of producing approximately 1500 barrels per stream day of 94.0 Research octane clear alkylate.

The process unit investment cost above the 94 octane level is relatively constant up to about 97 octane pool, where it becomes necessary to operate the Platformer at higher severities. The next large investment increase occurs at 100 octane pool, at which time an additional investment of approximately $670,000 is required to install a Penex Isomerization unit to process approximately 1050 bpsd of pentanes and hexanes.

At 101 octane pool it will be necessary to convert the Platformer to a Rexformer, at an investment of approximately $1 million. The unit will then be capable of producing 100 octane Research clear Rexformate. As a matter of interest, the total amortization costs for the incremental investment required at the 101 pool octane level, based on a factor of 10 percent per year, amounts to only 12.2 cents per barrel of finished gasoline.

The total incremental manufacturing costs expected in increasing the pool gasoline octane level from 93 to 101 Research is illustrated in Figure 2 by the solid line. The two major components comprising the solid line are represented by the other two curves. The dashed line indicates the incremental tetraethyl lead costs, while the dotted line shows incremental processing costs.

Does It Pay Out? Surprisingly enough, based on today's published cargo low prices at the Gulf Coast, there is an exceptionally attractive profit to be gained at the present time from producing this material.

Figure 8 illustrates the incremental motor gasoline price advantage for material exceeding 93 Research octane number. Shown in dollars per barrel, it indicates that 100 Research octane gasoline is worth $1.365 more at the Gulf today than 93 Research octane gasoline.

Figure 9 illustrates the profit margin available to the refiner based on previous cost calculations, versus the present market price. Again using the price advantage shown for 100 Research octane gasoline in published quotations, and subtracting from it the incremental cost of production, we find a net advantage of 91 cents per barrel for producing the 100 octane product. Furthermore, we have calculated that our hypothetical refinery will produce about 10,100 bpsd of 100 octane pool gasoline. By altering his processing scheme to permit the production of 100 octane pool, our refiner could improve his profit position today by approximately $9200 per stream day, or some $3,200,000 annually. Equipment is paid for in about 12 months.

What is the time interval between the inception of the idea and the completion of the project based on normal refinery construction standards? It usually ranges from 18 to 24 months. Effectively, this means we must anticipate our processing problems by at least that range of time.

Original presentation, of which this is a condensation, was before the Western Petroleum Refiners Association, San Antonio, March 25-27, 1957.

How Kaolin Works for Cat Cracking

Here are some commercial and pilot plant data which show how kaolin catalyst compares with other catalytic cracking catalysts.

D. Beyler, J. B. Maerker and J. W. Schall
Houdry Process Corporation
Philadelphia

THE COMMERCIAL use of kaolin has the following advantages over bentonite clay catalyst:

1. F-1 clear or leaded octane rating of the gasoline is substantially higher at constant operating conditions. Gasoline yield is the same or higher.
2. Coke yield is lower.
3. Catalyst breakage is lower.
4. Kaolin can be used to process high sulfur stocks.

It has the following advantages over synthetic catalyst:

1. Gasoline yield is higher.
2. Daily catalyst costs are substantially lower because of lower cost per ton together with the same or lower make-up rate.

The advantages over either bentonite or synthetic catalysts are:

1. Kaolin is much more stable toward steam and temperature deactivation.
2. Instantaneous carbon burning rates are much higher. Consequently, in any unit which is limited in coke burning capacity by kiln volume, the use of kaolin will increase the coke burning capacity substantially.
3. Equilibrium unit activity is higher. Therefore, charge rate can be increased and conversion level maintained constant or conversion level can be increased at constant charge rate.

Kaolin is a naturally occurring clay which contains approximately 45 Wt. percent alumina (as Al_2O_3). Silica constitutes the only other major component. A typical analysis of kaolin is shown in Table 1 on an ignited basis. The kaolin deposits which are used as a catalyst source are processed by a method developed jointly by Houdry Process Corporation and Minerals and Chemicals Corporation of America.

The physical and cracking characteristics of bentonite clay and synthetic type catalysts are well established by years of laboratory and commercial usage. The limitations of these catalysts for moving bed catalytic cracking purposes are also well established. These limitations are:

For bentonite clay:

1. Subject to sulfur poisoning.
2. Relatively low gasoline octane level.
3. Limited steam and temperature stability.
4. Limited unit activity.

For synthetic type catalysts:

1. Limited steam and temperature stability.
2. Limited unit activity.
3. Difficulty of regeneration.

Kaolin catalyst overcomes these limitations to a major extent.

Steam and Thermal Stability. The steam and thermal stability of kaolin catalyst compared with bentonite and synthetic type catalysts is shown in Figure 1. In these accelerated aging tests, the catalysts were held at the depicted temperature for four hours in steam at atmospheric pressure. Following this the catalysts were subjected to the standard laboratory Cat-A activity tests. Figure 1 presents the Cat-A gasoline yield as a function of steam treat temperature. Kaolin catalyst maintains its Cat-A activity up to a temperature in excess of 1550 F. before showing any marked deactivation. Bentonite and synthetic type catalysts, on the other hand, show rapid deactivation at temperatures well below 1400-1500 F.

TABLE 1
Typical Analysis of Kaolin Cracking Catalyst

COMPONENT	Weight Percent Ignited Basis
Al_2O_3	45.0
SiO_2	53.0
Fe_2O_3	0.3
Other Oxides	1.7
	100.0

In terms of commercial operation this means that (1) in units utilizing kaolin catalyst, kilns can be operated at temperature levels substantially in excess of those using bentonite and synthetic type catalysts without fear of steam-thermal deactivation or (2) a higher unit activity can be maintained when using kaolin catalyst. The higher temperature stability is of particular importance in the case of kilns with limited coke burning capacity and in case of unavoidable temperature upsets.

Sulfur Stability. Kaolin catalyst can be used equally well in the cracking of sweet or very sour stocks. It is very similar to synthetic catalyst in that it is not deactivated or poisoned by sulfur compounds.

Regenerability. Regeneration characteristics of the subject catalysts are presented in Table 2. Laboratory determined carbon burning rate constants are shown for regeneration temperatures of 850, 1000 and 1100 F. The rate of carbon burnoff from catalyst is proportional to the burning rate constant. Thus, the data of Table 2 shows that kaolin exhibits substantially higher carbon burning rates than either bentonite clay or synthetic type catalysts.

The increased regenerability of kaolin catalyst is of particular importance in the case of commercial kilns which are limited in coke burning capacity because of volume limitations when using bentonite or synthetic catalysts. The use of kaolin catalyst in such a unit results in increased kiln coke burning capacity, which in turn

How Kaolin Works for Cat Cracking . . .

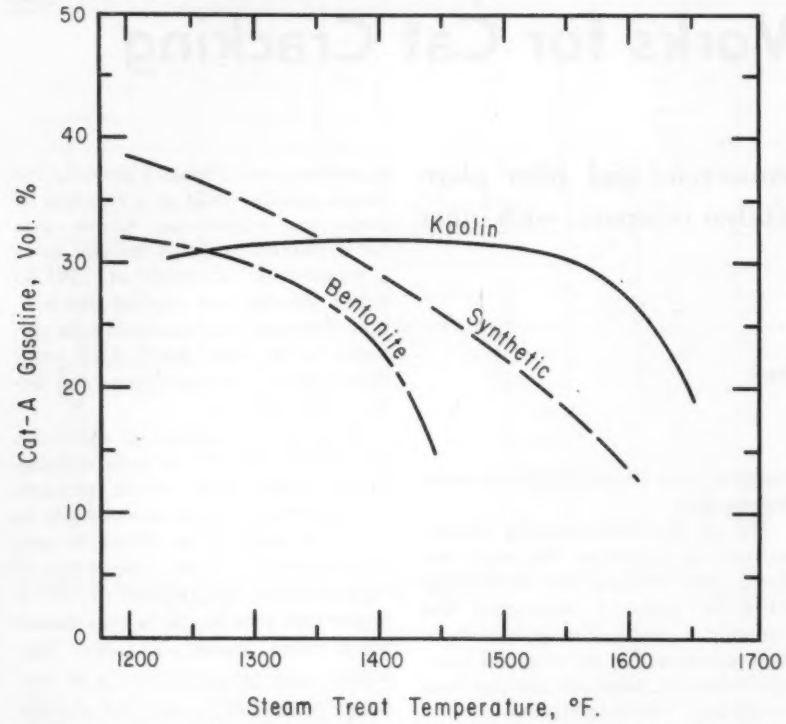


FIGURE 1—Steam-thermal stability of kaolin, synthetic and bentonite type catalysts. Basis: Four hours @ temperature in one Atm. abs. steam.

permits either higher gas oil charge rates or greater depth of cracking. The outstanding regeneration characteristics of kaolin have been attested by commercial experience in units containing a mixture of kaolin and bentonite clay and/or synthetic catalysts. In cases where coke burnoff has been incomplete, the kaolin catalyst in the mixture contains considerably less residual carbon than either the bentonite clay or synthetic catalysts.

Comparison of Cracking Characteristics of Kaolin and Bentonite Catalysts. Pilot plant data comparing typical cracking characteristics of kaolin catalyst and an equilibrium bentonite clay catalyst are presented in Table 3 for cracking a sweet gas oil at a conversion of 50 volume percent. All operating conditions were the same for both catalysts with the exception of the space rate. Space rate was varied to give the desired conversion level. Important aspects of the comparative data presented in Table 3 are enumerated as follows:

1. Kaolin has a considerably higher unit activity than bentonite clay. At otherwise constant reactor conditions, kaolin gives the same conversion level at a much higher space rate than bentonite clay.

2. Although the direct gasoline yield obtained by kaolin is indicated to be less than that obtained from bentonite clay at the same conversion level, the ultimate gasoline yield available by supplementary alkylation and polymerization processes is approximately the same for kaolin and bentonite. This results from increased yields of isobutane, and C_3 and C_4 unsaturates from kaolin.

3. Kaolin gives slightly less coke than bentonite clay.

4. Kaolin yields a gasoline with an octane level approximately 3 numbers (F-1 clear) higher than produced with bentonite clay at equivalent reactor temperature conditions.

5. Kaolin will give the same gasoline octane rating as bentonite clay at approximately 40-50 F. lower reactor temperature. Since, in catalytic cracking, the gasoline yield increases as reactor temperature decreases at constant conversion, the same or higher gasoline yield will be obtained with kaolin as with bentonite clay at constant octane. This demonstrates the great flexibility available to the refiner with kaolin catalyst. Operation can be adjusted to maximize gasoline yield or to take advantage of the high octane potential available with kaolin.

Commercial data from the TCC unit of the Leonard Refineries, Inc. at Alma, Michigan are shown in Table 4. Kaolin catalyst addition was started in December, 1955, with the catalyst added to replace normal unit losses. Thus the kaolin gradually replaced the bentonite clay in the unit. Table 4 compares operating data from the period of September and October, 1955, representing operation before kaolin addition with data from the period of September to November, 1956, when the kaolin concentration ranged from 60-80 Wt. percent. The effects of kaolin catalyst upon the

TABLE 2
Regeneration Characteristics

	Carbon Burning Rate Constant (Sec.$^{-1}$ x 10^3)		
Temperature, F.	850	1000	1100
Catalyst:			
Kaolin	0.26	2.8	5.8
Bentonite Clay	0.21	1.6	2.8
Synthetic	0.18	1.3	2.5

TABLE 3
Pilot Plant Operation on a Gas Oil From East Texas Crude

	Kaolin	Bentonite Clay
Operating Conditions:		
Temperature, F	900	900
Cat/Oil Ratio, W/W	4.5	4.5
Space Rate, V/H/V	1.8	1.0
Yields:		
Conversion, Volume Percent	50.0	50.0
Gasoline, 385 F. @ 90%, Vol. %	38.2	40.7
Total C_4 Cut, Volume Percent	12.2	10.2
nC_4, Volume Percent	1.1	1.1
iC_4, Volume Percent	5.1	4.1
$C_4^=$, Volume Percent	6.0	5.0
Total C_3 Cut, Volume Percent	7.0	6.2
Sat. C_3, Volume Percent	1.8	1.8
Unsat. C_3, Volume Percent	5.2	4.4
C_2 and Lighter, Weight Percent	1.9	1.9
Coke, Weight Percent	3.6	3.8
Gasoline Octanes:		
F-1 Clear	92.7	89.7
F-1 + 3cc TEL	98.6	96.5

TABLE 4
Commercial Operation of Leonard Refineries, Inc., Alma, Mich.

	Before Kaolin	After Kaolin
Kaolin in Unit Catalyst, Wt. %	0	60–80
Operating Conditions:		
Virgin Charge, BPM	150,860	183,141
Recycle Charge, BPM	34,395	29,752
Total Charge, BPM	185,255	212,893
Recycle Ratio, V/V	0.23	0.17
Reactor Outlet Temp., F	864	849
Catalyst Circulation, TPH	131	122
Yields—Fresh Feed Basis:		
Conversion, Volume Percent	50.2	51.7
Gasoline, Volume Percent	39.1	40.4
Poly Gasoline (C_4 only), Vol. %	2.2	2.2
C_4 Cut (After Poly), Vol. %	2.5	3.8
C_3 Cut, Volume Percent	2.0	2.0
C_2 and Lighter (FOE Basis), Volume Percent	6.0	4.7
Coke, lbs./hour	4300	3600
Gasoline Octane Rating:		
F-1 + 3cc TEL	95.4	95.8
Catalyst Residual Carbon:		
Weight Percent	0.42	0.03

Leonard operation are listed as follows:

1. The increased unit activity of kaolin has permitted a 20 percent increase in virgin charge to the unit and has increased conversion despite this higher charge rate. The higher conversion level was also attained in spite of reduced reactor temperatures and reduced catalyst to oil ratios, both of which give lower conversion.

2. The total gasoline yield increased more than 1 volume percent. Coupled with the higher charge rates permissible with kaolin, the actual gasoline production barrels increased approximately 25 percent.

3. Yields of C_2 and lighter hydrocarbons have decreased substantially.

4. Kaolin operation has given a significantly reduced coke load in spite of increased unit throughput.

5. The gasoline octane rating increased even though the reactor outlet temperature was 15 F. lower.

6. The increased regenerability of kaolin together with the lower coke yield has almost eliminated the presence of troublesome residual carbon on the regenerated catalyst.

These commercial data on kaolin and bentonite differ from the pilot plant data in one very important respect. The cracking efficiency, or gasoline yield per unit conversion, is very much higher in commercial operation than predicted from pilot plant data. Pilot plant data indicated that at constant temperature and conversion, bentonite produced more gasoline than kaolin. The commercial data indicate that gasoline yield obtained with kaolin is the same as obtained with bentonite at constant temperature and conversion. In addition, this gasoline is of substantially higher octane rating. This same effect is confirmed in other commercial units where kaolin has replaced bentonite clay.

TABLE 5
Pilot Plant Operation on a Gas Oil From an Arabian Crude

	Kaolin	Synthetic
Operating Conditions:		
Temperature, F	900	900
Cat/Oil Ratio, V/V	5.0	5.0
Space Rate, V/H/V	3.4	1.6
Yields:		
Conversion, Volume Percent	50.0	50.0
Gasoline, 385 F. @ 90%, Vol. %	37.2	35.8
Total C_4 Cut, Volume Percent	12.0	12.9
nC_4, Volume Percent	1.2	1.3
iC_4, Volume Percent	4.6	5.4
$C_4^=$, Volume Percent	6.2	6.2
Dry Gas, Weight Percent	6.1	6.1
Coke, Weight Percent	4.2	4.2
Gasoline Octane Ratings:		
F-1 Clear	92.6	92.3
F-1 + 3cc	97.8	97.4

Comparison of Cracking Characteristics of Kaolin and Synthetic Catalysts. A typical pilot plant comparison of the cracking characteristics of kaolin and synthetic catalysts when cracking an Arabian gas oil is presented in Table 5 at a constant conversion level. All operating conditions were the same for both catalysts with the exception of the space rate which was varied to give the desired conversion.

In general, these pilot plant data indicate that the cracking characteristics of kaolin and synthetic catalysts are similar in many respects. Both catalysts are sulfur resistant. Both catalysts give the same high gasoline octane ratings at comparable reactor temperatures. The yield structures exhibited by the two catalysts are also quite similar. Some salient differences of the catalysts are as follows:

1. Kaolin exhibits a higher unit activity than equilibrium synthetic catalyst. At otherwise constant reactor conditions kaolin gives the same conversion level at a higher space rate than synthetic.

2. Kaolin gives a higher gasoline yield than synthetic catalyst.

3. The isobutane yield obtained with kaolin is somewhat less than that of synthetic catalyst. However, the increased unit activity of kaolin permits higher conversion so that the actual production of isobutane on a barrels per day basis would be at least as great with kaolin.

4. Kaolin catalyst is substantially less expensive than synthetic catalyst.

Several commercial cracking units which previously had used synthetic catalyst are now using kaolin. Detailed data from these units cannot be disclosed at this time. However, the same discrepancies between pilot plant and commercial data previously described on kaolin and bentonite comparisons are also evident on kaolin and synthetic comparisons. Cracking efficiency obtained commercially with kaolin is higher, thus higher gasoline yields are obtained. The hardness characteristics of kaolin are such that attrition losses are the same or lower than obtained with synthetic catalyst. This, together with the lower cost per ton of kaolin, results in substantial savings in daily catalyst costs.

ACKNOWLEDGMENT

The authors wish to express their appreciation to Leonard Refineries, Inc. for permission to use their operating data and particularly to J. S. Pfarr and C. E. Fiske for their cooperation.

About the Authors

Beyler

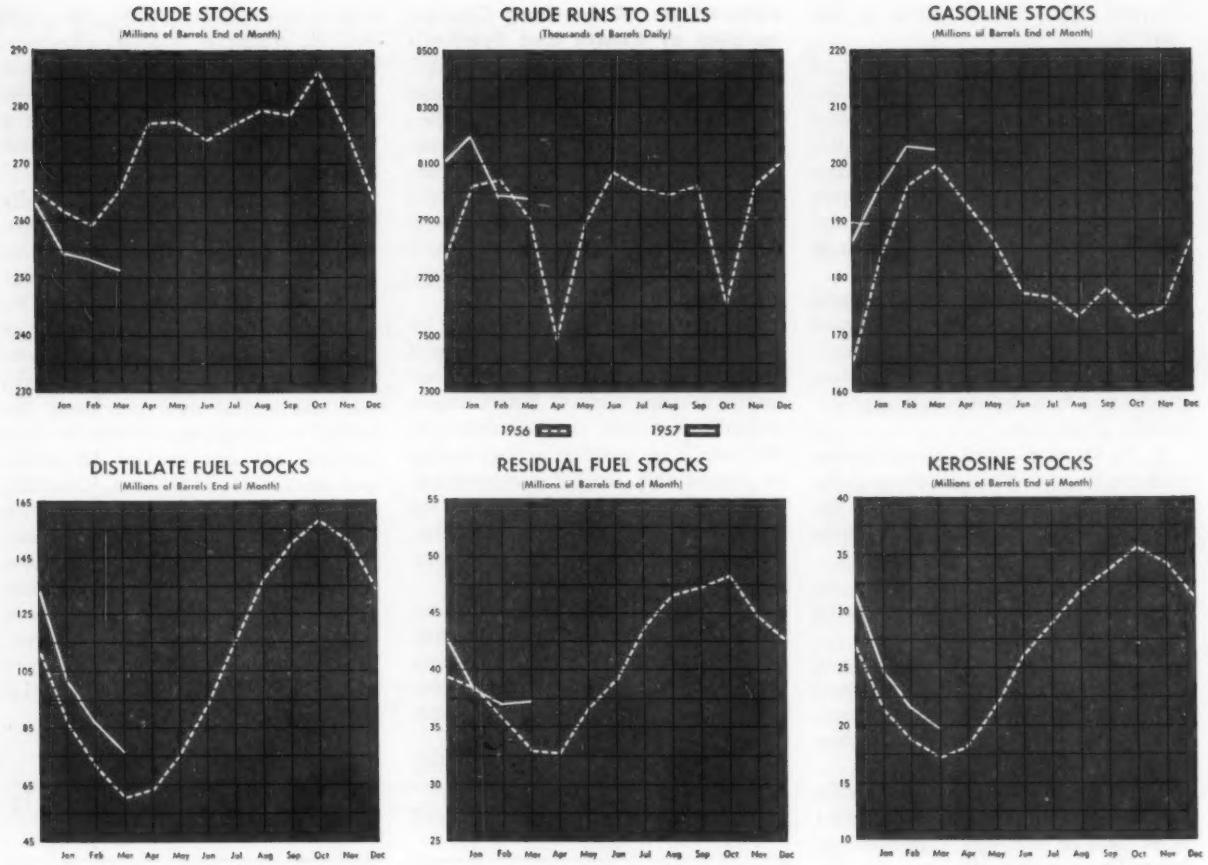
Maerker

Schall

DUDLEY BEYLER is product sales engineer in the Chemicals division of Houdry Process Corp. He received his B.S. degree in chemical engineering in 1951 from the University of Pennsylvania and has taken graduate courses at the University of Pennsylvania. He joined Houdry in 1951 as a process development engineer.

JOHN B. MAERKER received his B.S. degree in chemical engineering from the University of Tennessee in 1943. At that time he joined the Houdry Process Corp. as development engineer and is now serving as director of development at the Houdry research and development laboratories, Linwood, Pa.

JOSEF W. SCHALL received his B.S. degree from Lehigh University and his M.S. degree from the University of Rochester. He joined Houdry Process Corp. in 1944 as a development engineer, and in 1948 he was made section chief of process development. In 1955 he was appointed assistant manager of marketing. In 1956, Schall assumed his present position as manager of catalyst sales.


CRUDE STOCKS
(Millions of Barrels End of Month)
CRUDE RUNS TO STILLS
(Thousands of Barrels Daily)
GASOLINE STOCKS
(Millions of Barrels End of Month)
DISTILLATE FUEL STOCKS
(Millions of Barrels End of Month)
RESIDUAL FUEL STOCKS
(Millions of Barrels End of Month)
KEROSINE STOCKS
(Millions of Barrels End of Month)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1956
1957

Taking Stock

Cecil W. Smith
Economics Editor

- **Refinery runs at 3-months low**
- **Gasoline stocks start to dip**
- **Imports highest since December**

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:													
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,125
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	290	26,111	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	296	28,990	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	313	31,826	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	329	33,588	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	356	35,667	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	384	34,329	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	379	31,420	1,981	133,981	1,288	44,491	873	1,471
1957:													
January	7,480	8,274	256,669	3,991	197,702	367	24,019	2,118	100,572	1,322	38,403	805	1,425
February	7,682	8,088	256,344	3,864	205,270	353	21,013	2,035	85,105	1,270	31,201	780	1,430
March	7,784	8,042	252,313	3,704	203,412	325	19,980	1,856	75,615	1,219	37,311	860	1,457
Week Ended:													
4-26-57	7,537	7,634	257,081	3,744	200,222	235	20,163	1,765	74,898	1,191	36,800	880	1,462
4-27-56	7,146	7,447	273,522	3,557	190,188	315	17,894	1,695	61,923	1,123	32,476	835	1,264

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

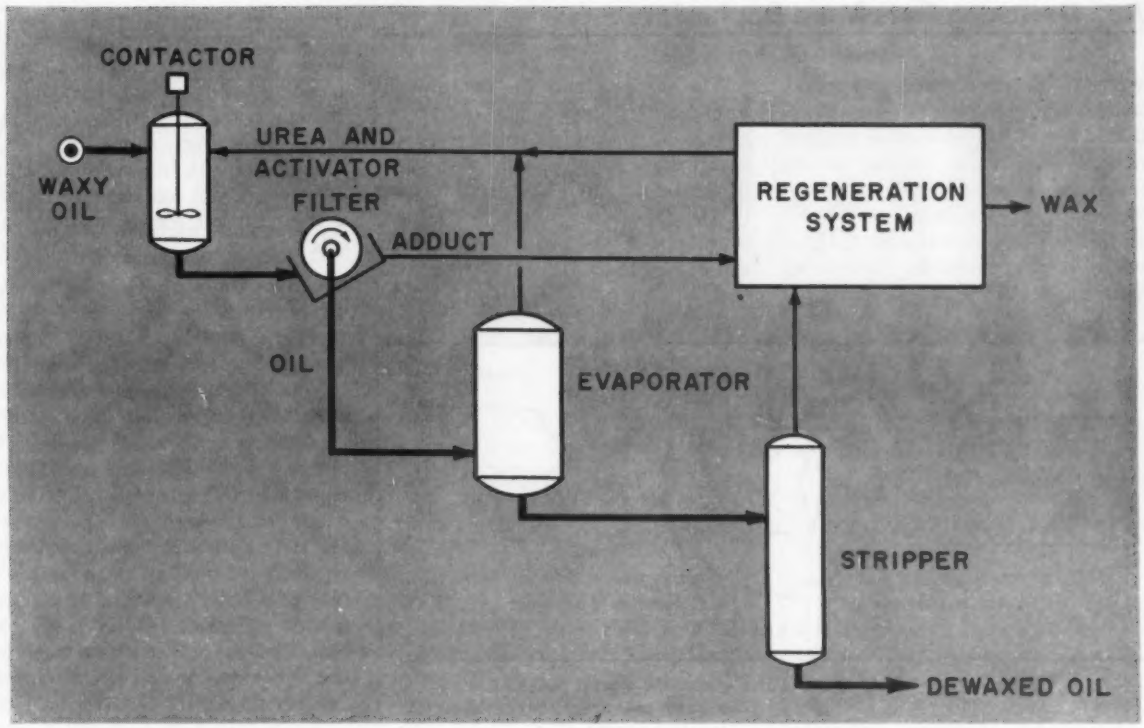


FIGURE 1—The pilot-plant program led to the development of the commercial process shown here.

Urea Dewaxing Gets More Emphasis

Here are some of the points which were considered before urea dewaxing was put into commercial operation for low- cold-test oil production.

T. H. Rogers, J. S. Brown, Robert Diekman and G. D. Kerns
Standard Oil Company (Indiana)
Whiting, Ind.

A NEW SEPARATION technique that operates at ordinary temperatures—urea adduction—offers a possible approach to making low-cold-test oils from waxy crudes. No longer must wax-free crudes be used to make oils with pour points of —20 to —50 F. that are needed or refrigerator oils, transformer oils, automatic-transmission fluids, hydraulic fluids and lubricants for Arctic service.

In this technique, separation of mixtures of organic substances is based on the formation of a solid complex. In 1940 in Germany, Friederich Bengen discovered that urea and n-decyl alcohol formed a crystalline complex when mixed.[1,6] He soon found that straight-chain hydrocarbons like n-octane formed similar complexes with urea, whereas branched-chain hydrocarbons like iso-octane would not. Upon disclosure of Bengen's discovery, which did not come until after the war, work on this phenomenon was promptly undertaken in many laboratories.[2,5]

Urea Adduction. Urea selectively crystallizes around organic compounds with long straight chains to make a solid, filterable complex or adduct. This selectivity of adduct formation is a function of the cross-section of the organic molecule as related to the geometry of the urea crystal. Figure 2 shows in cross section these relationships for hydrocarbon molecules of different shapes and sizes. In forming the adduct, the urea crystal forms a channel large enough to accommodate straight-chain hydrocarbon molecules like n-octane, but not cyclic or branched-chain hydrocarbons like benzene or iso-octane.[7]

Several molecules of urea are needed to form a complex with one

molecule of an organic compound. Contrary to the rule for a strictly chemical reaction, this ratio changes with the molecular weight of the compound. Figure 3 shows that approximately 0.7 mole of urea is required for each carbon atom.[6] However, because molecular weight of hydrocarbons is nearly proportional to the number of carbon atoms, the ratio on a weight basis is almost constant—roughly three pounds of urea to one pound of hydrocarbon.

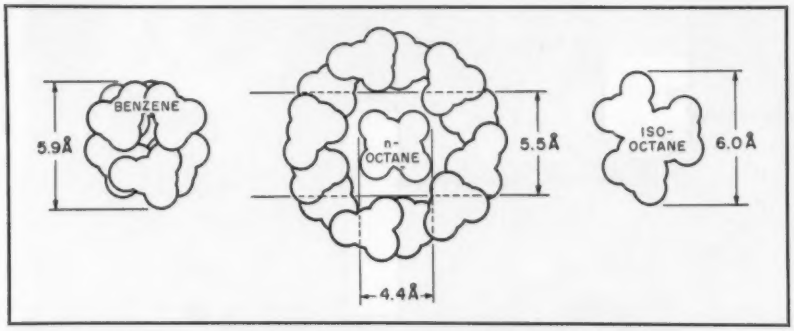


FIGURE 2—Urea selectively crystallizes around the organic compound.

Exploratory Studies. To explore the possibilities of adduction as a separation process, our laboratory undertook a general study of the variables of this reaction. Because of the straight-chain character of paraffin wax, waxy distillates were included in the reactants studied, as well as naphthas and pure hydrocarbons. Early findings were published several years ago;[8,9] parallel work by others is in good agreement.[2,5]

An activator, such as methanol, is essential to complete adduct formation in a reasonable time. With either a small amount or enough to dissolve the urea, adduct formation with straight-chain hydrocarbons is complete in a few minutes to an hour or more. The time required increases with increasing molecular weight of the hydrocarbon. Other alcohols, esters, ketones, or water may also be used as activators.

The adducts of hydrocarbon waxes are stable enough to be washed with inert solvents to remove uncomplexed hydrocarbons. Without this stability, urea adduction would not be a practical separation tool. Large amounts of raffinate liquid would be occluded in the adduct solids after settling, filtering, or even centrifuging.

The adduct can be decomposed and the original components recovered by agitating at room temperature with a good solvent for urea, or by heating. Water is commonly used in the laboratory, often with some heating. For decomposition by heat alone, a temperature of 200 F. will quickly decompose adducts of high-molecular-weight hydrocarbons. The ease with which the components of the adduct can be recovered is obviously advantageous for commercial operation.

Such experiments indicated that petroleum distillates could be dewaxed by contacting them with urea and an activator, separating the crystalline adduct from dewaxed oil, and heating the adduct to recover urea and wax. Time, temperature, and separation conditions seemed adaptable to a commercial process. Preliminary cost estimates indicated that urea dewaxing could not usually compete with solvent dewaxing, although L. Sonneborn is operating a urea plant for removing small amounts of wax from white oils,[3] and Deutsche Erdöl has recently installed a urea process for dewaxing spindle oils.[4]

Process Development. Our consideration of the problem of producing light lubricating oils of sub-zero pour point from waxy distillates led to the concept that urea dewaxing should be considered as a complement to conventional dewaxing. That is to say, urea dewaxing could not be expected to compete with solvent dewaxing for lowering the pour test as far as O F., but it seemed well suited to further lowering the pour test of oils previously dewaxed by established techniques. Our study was therefore directed to a two-step operation: solvent or other conventional dewaxing, followed by urea dewaxing.

Bench-scale tests were made to explore the practicability of this two-step operation with the results shown in Figure 4. Desired pour points of —40 to —50 F were obtained by urea dewaxing of previously dewaxed Mid-Continent stocks of 0 to 25 F pour point. The pour point of urea-dewaxed stocks varies greatly with viscosity, primarily because some of the waxy hydrocarbons in the higher viscosity range are not adductable with urea. The two-step operation

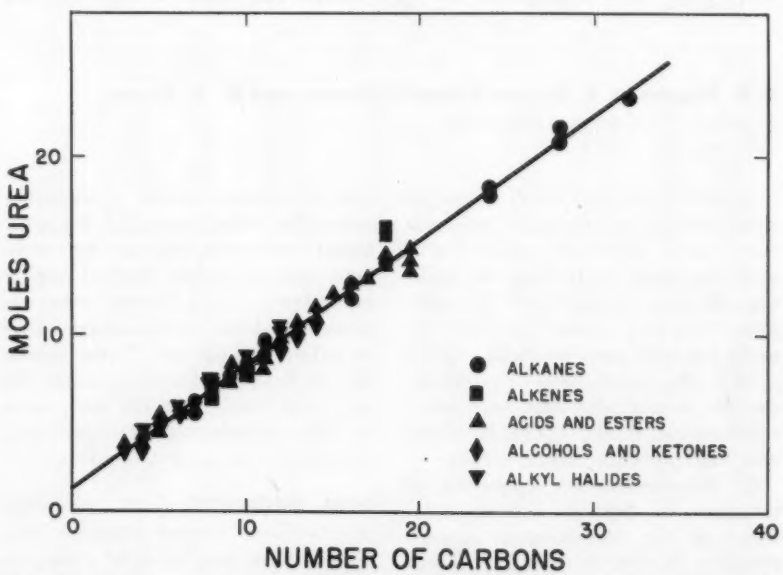


FIGURE 3—About 0.7 mole of urea is required for each carbon atom in order to form a complex.

removes about the same amount of wax as solvent dewaxing to the same pour point. These data indicate that the urea teachnique is particularly well adapted to the light lubricating stocks most often used for low-cold-test oils.

These findings led to an extensive development program. Feeds used were refinery solvent-dewaxed oils that ranged in viscosity from 50 to 220 SSU at 100 F. Three sizes of contactors were used to study process variables and to prepare slurries for filtration tests. A 12-inch plastic contactor, employed for both batch and continuous experiments, is shown in Figure 5; a smaller reactor of glass and a larger one of steel were also successfully used.

Results obtained from urea dewaxing three feeds are shown in Table 1. The low pour point of the products confirmed the findings of the bench-scale work. As in any dewaxing operation, removal of a paraffinic byproduct raises viscosity and lowers viscosity index. The byproduct consists of bright liquid waxes of unusually high gravity and high viscosity index. They are being studied for special uses and as chemical raw materials.

An adduct cake that can be handled and washed in an inexpensive conventional rotary filter was readily obtained. Figure 6 shows a typical filter leaf before and after test. The cake shown has good porosity and moderate compressibility, can be washed in place on the drum, and discharges cleanly from the cloth.

About the Authors

Rogers | Brown | Diekman | Kerns

T. H. ROGERS is director of research at the central laboratory at Whiting for Standard Oil Co. (Indiana). Here he supervises research and development work on petroleum refining at the central laboratory. Rogers received his A.B. degree from Centre College in 1914, and his Ph.D. degree from Johns Hopkins University in 1917. In 1922 he assumed his present position.

J. S. BROWN is a research chemist for Standard Oil Co. (Indiana) where he does basic studies in lubrication and industrial lubricants. Brown received his B.S. degree from the University of Chicago in 1940, and in 1941 he joined DuPont. He came to Indiana-Standard in 1948.

R. DIEKMAN is a group leader in the Technical Service division of the Research department of Standard Oil Co. (Indiana), Whiting. He received his M.S. degree in chemical engineering in 1944 from Northwestern University. He has worked for Indiana Standard as a chemical engineer in pilot plant and technical service work since July, 1947.

G. D. KERNS is a process engineer for Standard Oil Co. (Indiana), Whiting, where he does process design of refining processes. Kerns received his B.S. degree in 1949 from the University of Minnesota, and his M.S. degree in 1953 from the University of Delaware. He has been a chemical engineer for Indiana Standard since 1954.

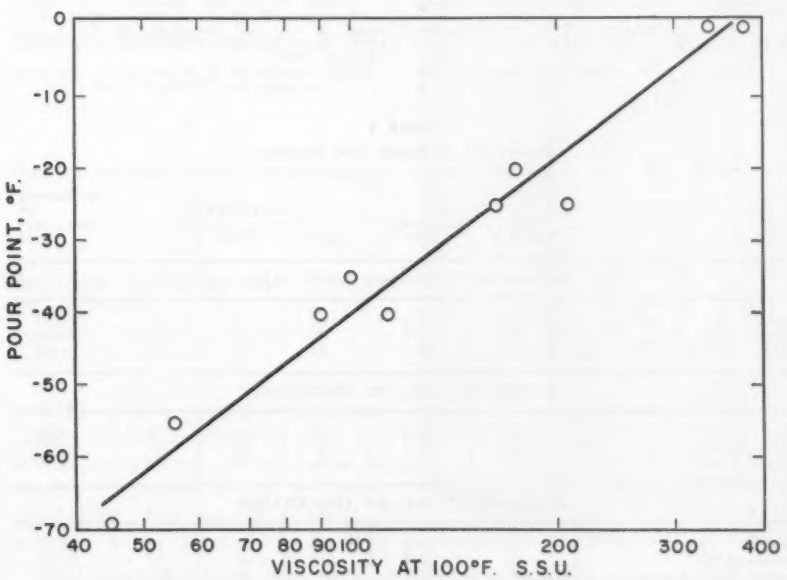


FIGURE 4—The pour point of urea dewaxed stocks varies greatly with viscocity.

Resulting Process. This program led to the development of a continuous process, as shown in Figure 1. It operates at ordinary temperatures, in contrast with temperatures below —50 F that would be required for conventional dewaxing processes. Low-cold-test oil is separated from the adduct on a rotary filter of conventional design. The adduct cake is decomposed into urea, which is recycled to the process, and the paraffinic byproduct.

This process was embodied in the design of a plant to dewax a nominal 1000 barrel per stream day of light lubricating stocks of 50 to 220 SSU viscosity to the pour points shown in Table 1. Because low-viscosity feeds contain more adductable material,

feed rate and product yield vary with feed viscosity:

Feed Viscosity, SSU at 100 F	Feed Rate, BPSD	Product Yield, Vol. %
50	900	85
80	1000	86
220	1200	94

Investment cost for a plant to process these quantities of feed has been estimated at $850,000. A solvent-dewaxing plant designed to do the same job would be much more expensive. Direct comparison of the two would therefore have little significance. For orientation, however, a conventional solvent-dewaxing plant of the same size, but designed to produce an oil of 0 F pour point, would cost about the same amount.

Operating costs for the two processes, in cents per gallon of product, are also about the same:

	Urea Dewaxing for Low-Pour Oils	Solvent Dewaxing for Medium-Pour Oils
Labor	0.6	0.6
Maintenance	0.7	0.3
Utilities	0.8	1.1
Chemicals & Solvents	0.1	0.1
Total	2.2	2.1

Most solvent dewaxing plants are larger and, therefore, more economic. Liberal allowance has been made for maintenance in the case of urea dewaxing, because of lack of experience with full-scale operation; maintenance costs may well be lower in the long run.

A plant employing the developed process has just been built at Standard's refinery at Whiting, Ind. Process and mechanical features are now being tested preparatory to the first run.

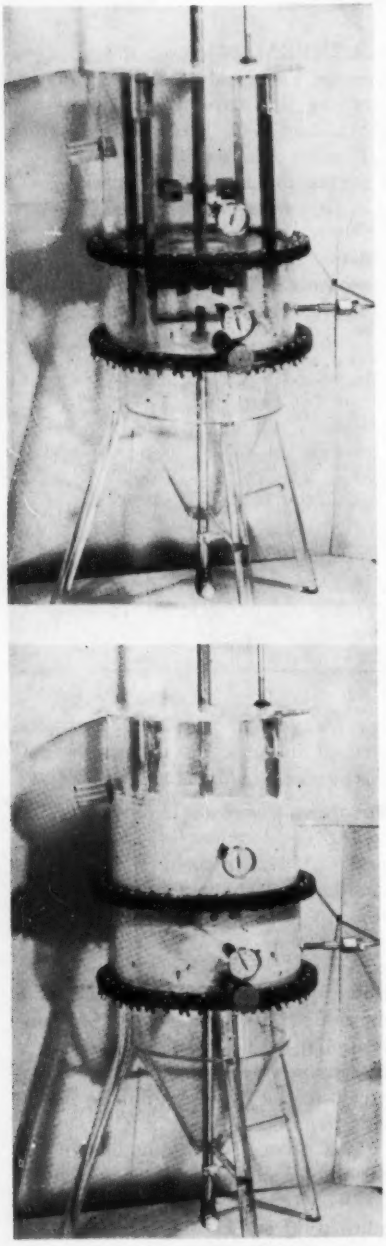


FIGURE 5—A 12-inch plastic contactor was employed for both batch and continuous experiments.

BEFORE FILTRATION

AFTER FILTRATION

FIGURE 6—The filter cake has good porosity and moderate compressibility, can be washed in place and discharges cleanly from the cloth.

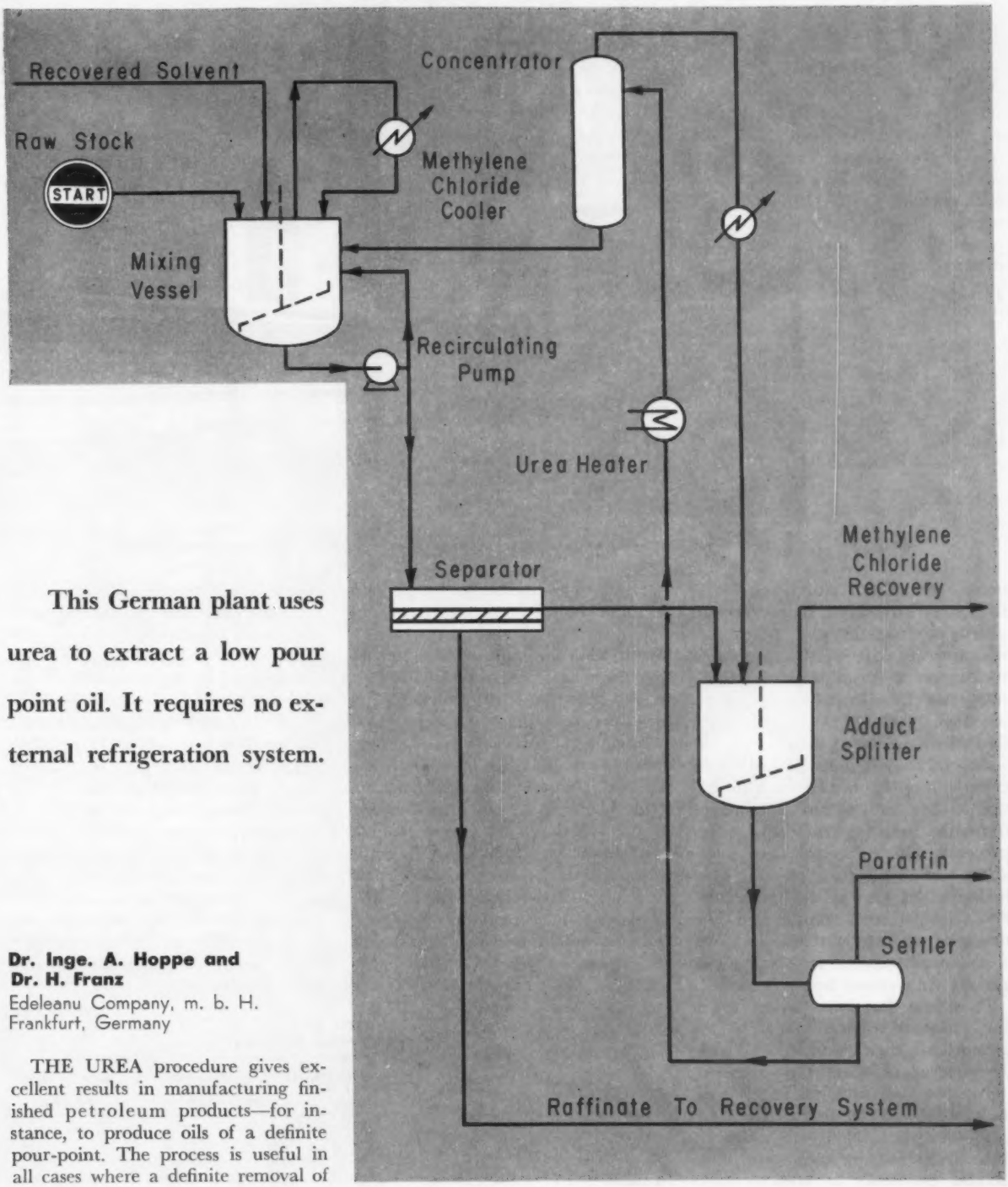
LITERATURE CITED

[1] Bengen, M. F., German Patent Appl. O. Z. 12438 (March 18, 1940); Patent 869,070 (January 22, 1953).
[2] Brooks, B. T., Boord, C. E., Kurtz, Jr., S. S., and Schmerling, L., "The Chemistry of Petroleum Hydrocarbons" Vol. 1, pp. 241-274, Reinhold, New York, 1954.
[3] Chem. Eng. 63, 114 (1956).
[4] Hoppe, A., and Franz, H., Erdol u. Kohle 8, 411 (1955).
[5] Kobe, K. A., and Domask, W. G., Petroleum Refiner, 31, No. 3, 106; No. 5, 151; No. 7, 125 (1952).
[6] Marschner, R. F., Chem. Eng. News, 33, 494 (1955).
[7] Schlenk, W. Jr., Ann. 565, No. 3, 204 (1949).
[8] Zimmerschied, W. J., Dinerstein, R. A., Weitkamp, A. W., and Marschner, R. F., J. Am. Chem. Soc. 71, 2947 (1949); Ind. Eng. Chem. 42, 1300 (1950).
[9] Zimmerschied, W. J., Higley, W. S., and Lien, A. P., Petroleum Eng. 22, No. 7, C-43 (1950).

TABLE 1
Properties of Feeds and Products

	Pour Point, F.	Gravity, °API	VISCOSITY 100 F	VISCOSITY 210 F	VISCOSITY V.I.	Refractive Index, n_D^{20}
50-VISCOSITY OIL; 10% ADDUCTABLE						
Feed	15	30.5	59	35	78	1.4858
Dewaxed Oil	—55	29.0	64	35	69	1.4898
Liquid Wax	75	46.1	44	32	139	1.4449
80-VISCOSITY OIL; 7% ADDUCTABLE						
Feed	35	28.6	82	37	75	1.4906
Dewaxed Oil	—40	26.9	92	38	61	1.4953
Liquid Wax	60	43.0	55	35	158	1.4460
220-VISCOSITY OIL; 4% ADDUCTABLE						
Feed	0	26.0	229	51	66	1.4990
Dewaxed Oil	—25	25.6	246	47	64	1.5002
Liquid Wax	80	40.8	68	38	167	1.4579

Low Pour Oils Made by Urea Process



This German plant uses urea to extract a low pour point oil. It requires no external refrigeration system.

Dr. Inge. A. Hoppe and Dr. H. Franz
Edeleanu Company, m. b. H.
Frankfurt, Germany

THE UREA procedure gives excellent results in manufacturing finished petroleum products—for instance, to produce oils of a definite pour-point. The process is useful in all cases where a definite removal of

Original material in *Erdoel u. Kohle*, 8, No. 6, June, 1955. Translation by Edwin J. Barth, petroleum consultant, New York

FIGURE 1—Methylene chloride is the solvent used in the formation of the urea-hydrocarbon complex.

Low Pour Oils Made by Urea Process . . .

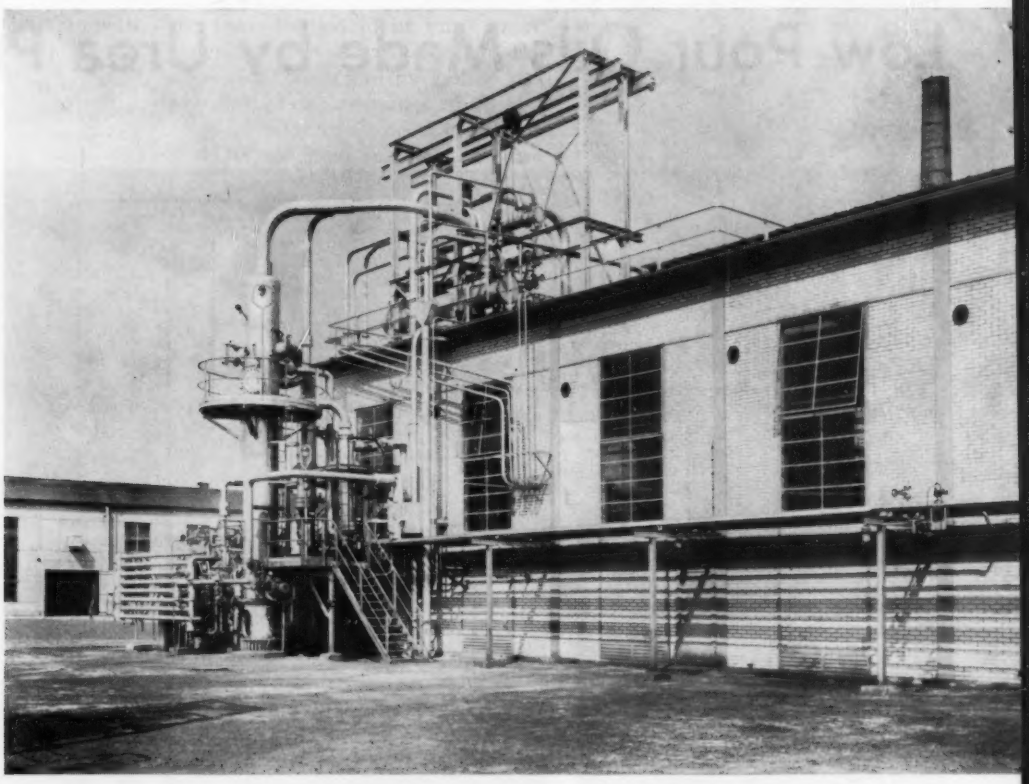


FIGURE 2—The solvent recovery apparatus is located outside of the urea dewaxing building

normal paraffins is required. No refrigeration is required. Low molecular weight oil fractions, such as the gas-oils and spindle oils having high melting-point waxes which are definitely not of the branched-chain type, are easily processed to any pour-point desired by the use of urea.

Several factors must be taken into consideration for the effective formation of urea-adducts, and their ease of formation from the crude stock being processed. One of the prime considerations is the type of solvent to be used both for the urea as well as for the liquid hydrocarbon constituents. The results of an investigation to use urea in the production of low pour-point gas oils are reported here.

Petroleum fractions containing a low content of n-paraffins can be dewaxed "as is" with urea only. Where the content of these n-paraffins is appreciable, we find the mixture of the raw oil and the urea dissolved in it thicken very rapidly to a heavy paste under stirring conditions. The mixture eventually becomes so thick that it can no longer be pumped or stirred. Such stocks must be diluted before urea addition or during adduct-formation.

Methylene chloride was chosen as the solvent for adduct-formation. It is well-known as a selective solvent in dewaxing operations. We were aware this solvent may show its maximum dewaxing ability at temperatures below the temperature of adduct-formation —40 C. Nevertheless, by employing this solvent when working with urea we find its wax separating ability is enhanced. If we were to use benzol or a nonadduct-forming solvent such as n-pentane or branched hydrocarbons instead of methylene chloride for diluting the raw stock, raffinates would be obtained with much higher pour-points. Other solvents similar to methylene chloride can be employed with about equally good results.

Methylene chloride, however, was also selected for the extraordinary advantage that its boiling-point of 41 C. lies in the range specifically used for maximum adduct-formation. The proper temperature may be retained simply by evaporating some of the solvent. Heat liberated by adduct-formation is counteracted or carried off by vaporization of a portion of the solvent, without any discernible temperature variations taking place. Furthermore, the solvent is stable and non-corrosive in the temperature ranges used; it is non-inflammable and low in cost.

TABLE 1
Effect of Various Solvents

SOLVENT	YIELDS (Wt.)		Pour Point, C.	Solid Point, C.
	*Raffinate	n-Paraffin	Raffinate	Paraffin
Benzol	85.8%	14.2%	— 7	39.5
Carbon tetrachloride	87.5	12.5	— 7	37.0
Methylene Chloride ($CH_2 \cdot Cl_2$)	85.6	14.4	—16	40.0
Ethylene Chloride ($DH_2 \cdot Cl \cdot CH_2 \cdot Cl$)	85.0	15.0	—16	40.0
50:50 Methyl Chloride & Ethylene Chloride	85.0	15.0	—15	40.0

* Raffinate—the oil portions entirely freed of n-paraffins
Raw Oil density of 0.842 @ 20 C, pour point of 17 C and viscosity of 1.7 E @ 50 C.

The effect of various solvents towards nonadduct-forming oily constituents and thus on the pour-point of a spindle oil is shown in Table 1. The raw oil was treated with 50 percent (by weight) of urea.

A desirable solvent for the urea, however, presents some difficulties, unless properly handled. The question of what solvent to use, or any at all, can only be answered relative to the adduct to be decomposed, the recovery and the re-use of the urea.

In order to form urea-adducts with n-paraffins it is only necessary to bring the two components of the reaction, that is, the urea and the paraffins together under active stirring conditions; adduct-formation is rapid when contact between the phases is intimate and thorough. Nevertheless unless a specific solvent for urea is employed, to obtain a very finely divided adduct by intense or intimate stirring would call for long time periods of agitation, heavy plant equipment and a large consumption of power. Using urea in solution form, the initiation and the duration of adduct-formation is truly activated and most intimate, with the time limits for completion reckoned in minutes instead of hours.

Among the important and most useful solvents for urea are water and the lower alcohols—especially methanol. Methanol has an advantage over water because it shows some solubility for hydrocarbon oils and the paraffins, affording a better contact with these and the urea in solution. Also the solubility of methanol in oil is low and limited, so that in the step of adding additional quantities of solvent after adduct-separation, one obtains a heterogeneous fluid—one phase of "dewaxed oil," the greater portion of the diluent, and a little urea and methanol; the other phase contains the remainder of the diluent, very little of the "dewaxed oil," most of the methanol, and the urea in solution not used up in adduct formation. This urea solution can be used for adduct-splitting later, as its urea content is much below saturation at the temperatures used for adduct splitting. The use of the solution in this manner can only be carried out in those cases where it is immaterial whether the separated wax contains adherent oils or not—for instance, in such cases where waxy materials are advantageously used as charge to cracking stills, etc. The oil content of such wax is of course quite low, but it is sufficient to lower the melting point of the wax appreciably.

As to the urea solubility relationships, water has the advantage over methanol as a solvent, especially in the 60 to 80 C. temperature range, as used in adduct-splitting. The decomposition of the adduct can then be carried out very much faster, and at lower temperatures, than with methanol. Moreover, the urea-balance is also much more favorable throughout the procedure since the heat-stability of urea very much depends on the duration heating-periods and temperatures used in recovering it from its solutions.

Urea adducts are broken up or decomposed by heating to about 130 C., when no solvent is used. In this case there results an upper layer composed of liquid paraffins, and a lower layer

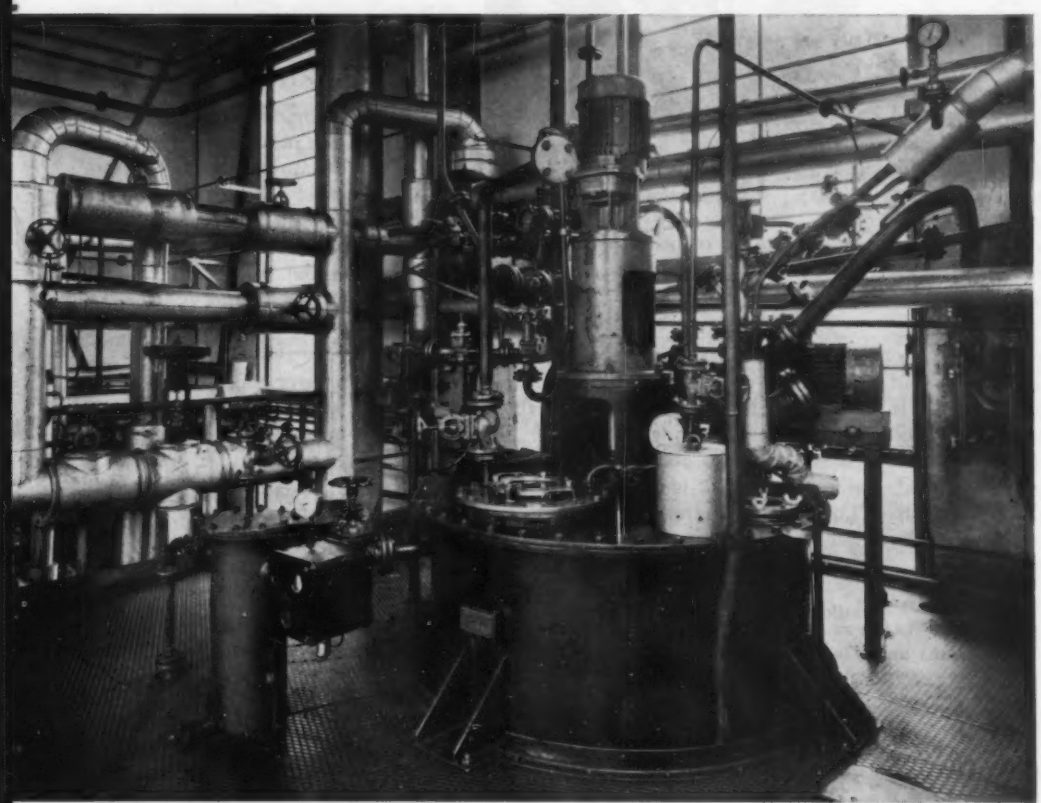


FIGURE 3—Equal parts by volume of raw oil, aqueous urea solution, and methylene chloride are mixed together in this mixing vessel.

of melted urea. To be sure, urea ordinarily more stable in the dry condition is none too stable in the presence of water or in aqueous solutions (such as might be formed by water entrained in the raw stock to be treated). However, at temperatures of 130 C., decomposition of urea becomes disagreeably noticeable. In view of that, a complicated problem results in trying to handle molten urea for later re-use. To avoid heating of dry urea in breaking-up the adduct, the use of some sort of solvent for the urea is necessary. In that case it is of decided advantage to add the solvent during adduct-formation and to speed the reaction as much as possible.

Adding up to ten percent water precipitates a finely divided adduct which calls for centrifuging in order to separate it. Additions of water from over ten to forty percent result in coarse-grained adducts. Then one observes that the oil film which envelopes the small grains, disappears during the agglomeration. The resulting mass consists of globular particles of about 10 mm. or more in diameter; moreover the interior of these particles is free of oil, adsorbing oil films only on newly formed interfaces. Simple separation methods, such as a series of screens is all that is needed to separate the solids from the reaction mixture. After agglomeration is completed total mix is pumped onto the screen arrangement; the oily raffinate drains off rapidly even at a cake thickness of 10 centimeters, and yields a product of desired pour point, after separating the diluent.

Using over forty percent water, adduct-formation is very poor and often does not take place at all. It results in forming emulsions of the oil and the urea solution, in which the solid adduct is found suspended. These mixtures are impractical to handle in the plant and can only be resolved by centrifuging.

A commercial plant was put into operation based on all the technical data obtained. This plant was put in operation by the Deutsche Erdoel A.G. in Heide, Germany, making use of the patents of the Badische Anilin u. Soda Fabrik.

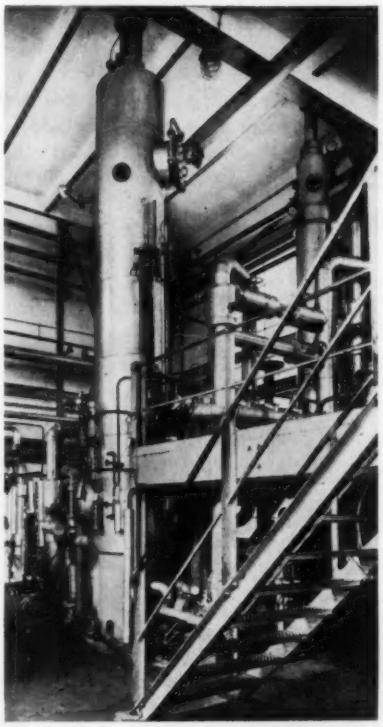


FIGURE 4—This concentrator reduces the water and methylene chloride content of the urea solution.

The flow sheet of the plant process is shown in Figure 1.

To operate, a charge of 100 parts (volume) of raw oil and 100 parts of methylene chloride are mixed thoroughly in the mixing vessel, with 100 parts (volume) of an aqueous solution of urea that is saturated at 70 C. Total components are there maintained at a maximum temperature of 40 C., during intimate mixing temperatures are maintained constant during mixing within a range of 35 to 45 C., preferably at 40 C., by evaporating part of the methylene chloride.

Evaporated methylene chloride is condensed in a cooler, and returned to the mixing vessel. Adduct formation takes place very rapidly after contact of the components in the charge. Intimate contact of the mix is obtained by strong and energetic agitation, and by means of a recirculating pump. Upon completion of adduct, the latter flows in controlled quantities (relative to incoming raw stock) to the separator, from which raffinate of desired pour-point is drawn off. The filtrate is pumped to the solvent-recovery unit (not shown) where methylene chloride is completely removed, yielding a solvent-free end product.

For economy of operation, the adduct cake at the Heide plant is next passed direct to the adduct splitter without any washing or deoiling. A temperature of about 75 C. is achieved as quickly as possible by using direct steam. Most of the methylene chloride present in the adduct is simultaneously driven off during the heating period, is next condensed and returned to the supply tank (not shown).

When decomposition of adduct is completed, the mix passes to a settler and there separates into two layers. The upper layer contains the n-paraffins together with traces of methylene chloride. The traces of solvent are distilled off in the recovery unit (not shown), condensed, and returned to the supply tank. The paraffin is drawn off to run-down tank.

The lower layer consists of a strong solution of urea, together with some methylene chloride. This solution is brought to a temperature of 80 C in a urea heater, then flows to a concentrator, where urea concentration takes place equivalent to saturation at 70 C. Water driven off is condensed in condenser 10, and is pumped for use in the adduct splitter. The concentrated solution of urea thus brought to pre-determined urea content is pumped back to the mixing vessel and is ready for a new cycle of adduct formation.

The results of dewaxing a spindle oil in the commercial unit at Heide are shown in Table 2. ##

TABLE 2
Results at Heide Plant

	Distillate	Raffinate	Paraffin
Yield (weight percent)	100.	75.	25
Density, 15 C.	0.870	0.885	—
Pour Point C.	14.	—24.	—
Cloud Point C.	15.	—21.	
Melting-Point C.	—	—	30*
Oils (weight percent)	—	—	50*
Viscosity, 50 C. (E)	1.66	1.75	—

* Without washing or final de-oiling treatment.

How to Test Condensers

Proposed AIChE Standard outlines procedure for testing performance of shell and tube type condensers.

TO CONDUCT performance tests on shell and tube condensers, AIChE has proposed a new standard testing procedure. This standard is part of the work being done on procedures for testing heat exchangers by the AIChE Committee on Equipment Test Procedures. It provides a standard means of comparing manufacturers' predicted performance.

Parts 5 through 7 are reproduced here in full. For the complete text of the first four parts, see Page 228. AIChE section numbers are indicated at the end of each paragraph in parenthesis.

5. Test Procedure. In general it is desirable that the conditions around the condenser be constant during the test, which should extend over a considerable period of time. To assume that steady state conditions exist, readings of all variables should be constant for a period at least equal to the length of the test, before the test data are recorded, and for a similar period after the test is completed. (5.1)

In the great majority of cases, the condenser to be tested will be only a component of an assemblage of a large number of inter-related pieces of equipment, all of which form a commercial unit. Hence, there will be great difficulty in maintaining conditions of operation as constant as is possible in the laboratory. To obtain as high an accuracy as possible, it is therefore necessary to continue the test for a longer time than would otherwise be the case, so that the averages of the readings taken will be more representative of the true conditions. It is suggested that at least ten sets of readings be obtained over a period of an hour. In no case should individual readings differ from each other by more than 10 percent of the smaller value for rates; for temperature differences, the 10 percent value of 5 F. should be used, which ever is smaller.

Performance tests of commercial condensers are normally run to determine one of the following (5.2):

- The condition of the equipment, i.e., its need for maintenance.
- The performance that can be expected at conditions differing widely from design.
- The performance under design conditions.

In the latter two cases it is desirable to clean the condenser immediately prior to the test. These tests which fall under the first classification normally are part of a series of tests. It is desirable to have one test of the series made under clean conditions for reference purposes.

In cleaning a condenser, the fundamental fact—that heat must flow through the fouling resistance on both sides of a tube, as well as through the tube wall itself—should always be borne in mind. Consequently, every attempt should be made to remove *all* traces of scale and to re-expose the entire prime metal surface. Experience to date tends to show that chemical methods will accomplish this better, in most cases, than any of the mechanical methods. The user of a heat exchanger should ascertain the best chemical reagent or solvent to remove his particular type of scale. In general, chlorine, copper sulphate, and other compounds have been found effective for the removal of biological growths; detergents such as trisodium phosphate and similar chemicals are satisfactory for mud deposits; inhibited acids, used in accordance with the supplier's recommendations, serve for lime deposits; and organic solvents, such as chlorinated hydrocarbon and petroleum solvents, have been found satisfactory for oily or tarry deposits. Where there is no solvent available

These men did the work . . .

This standard was prepared by the following members of the AIChE Committee on Equipment Testing Procedures:

W. R. Marshall, University of Wisconsin, General Chairman

C. H. Brooks, Sun Oil Company, Vice-Chairman, Sub-Committee on Heat Exchangers

C. H. Gilmour, Carbide and Carbon Chemicals Company, Chairman

W. C. Beekley, Witlock Manufacturing Company

C. F. Bonilla, Columbia University

W. M. Cooper, Monsanto Chemical Company

S. A. Guerrieri, The Lummus Company

R. M. Hubbard, University of Virginia

M. W. Martin, C F Braun & Company

P. S. Otten, The Griscom Russell Company

Extra copies of this standard are available at $1 each from F. J. Van Antwerpen, Executive Secretary, AIChE, 25 West 45th Street, New York 36, N. Y.

to remove a scale in its entirety (such as tarry coke), a combination of a chemical solvent followed by a mechanical cleaning has been found to be very effective. It might be pointed out that many established procedures may be extremely useful in removing a large percentage of the foreign deposits, but from a testing standpoint, they are not fully effective in that they do not re-expose the bare tube wall. (5.21)

The most complete published work to date on the cleaning of shell and tube type equipment is reported in Reference (4).

Representative samples of the stream to be condensed and of the cooling medium (if this be other than water) should be taken during the course of the tests so that physical properties and compositions may be checked at a later date, in the event that this becomes desirable. Standard procedure, or methods generally recognized in industry, should be used for sampling and for testing. Vapor samples should preferably be collected as liquids by drawing them through suitable total condensers, employing refrigerants, if necessary, to obtain complete condensation. When complete condensation is not possible, the volume of the non-condensables associated with the condensate sample should be determined, and a sample of the non-condensables should be collected. In those cases where there is any question of the stability of the material which has been sampled, a portion of the sample should be tested immediately so that the tests will give the true condition in the condenser. It should be further noted that in some cases there will be a spontaneous change in temperature upon standing, due to heat of solution or other effect. Therefore, the samples should be taken as close to the outlet of the condenser as possible. (5.3)

Special Procedures for Acceptance Tests. Due to the special nature of the "acceptance test," certain additional requirements become necessary, beyond those for a normal performance test. Scheduled in this section are items which modify or amplify other parts of this Testing procedure. (5A.1)

Guaranteed Performance. The desired performance of the condenser should first be clearly established and understood. It is highly desirable that agreement should have been reached between the purchaser and the manufacturer concerning the methods of calculation and the heat transfer equations used in sizing the condenser covered by the contract. All units should be clearly stated. It should be understood that the figures applying to the quantities listed below, which appear in the manufacturer's specifications and upon which he based his proposal from which the contract in question developed, indicate an agreement between the purchaser and the manufacturer as to these quantities. (5A.21)

The identification of all major components of each stream, i.e., both the stream to be condensed and the cooling medium, as to their essential physical properties in both the liquid as well as the vapor phase for the stream to be condensed, namely, specific gravity, thermal conductivity, and viscosity, the last at least at two temperatures. Any special physical properties, e.g., pour paint of stream to be condensed, should be covered. The specific heat of the cooling medium, unless this be a common material such as water, should be included. (5A.211)

An equilibrium, cumulative, condensation curve, a plot of the amount of vapor condensed versus temperature, based upon the actual inlet composition of the stream to be condensed. This plot should apply to a specified pressure, preferably the inlet pressure. If it be expected that there will be a substantial pressure drop through the condenser, the effect of pressure upon the condensation curve should also be specified. (5A.212)

A curve of total heat, or enthalpy, versus temperature, or the specific heats of the vapor and condensate, together with the applicable latent heats, if the total heat data for the stream to be condensed are not available. The curve should be at the pressure used for the condensation curve given in 5A.212 above. If the pressure drop through the condenser is expected to be large, additional curves giving the effect of pressure on the enthalpy or upon the specific and latent heats should be included. If there be appreciable heat of mixing which occurs upon condensation, data concerning this should also be included. (5A.213)

The flow rates of the major components of each stream, including the amount of each component that is to be condensed from the vapor stream, in the case of the stream which is to be condensed. (5A.214)

The terminal temperatures of all streams (for each phase if more than one exists). (5A.215)

The total heat to be transferred. (5A.216)

The inlet operating pressure for each stream. It is suggested that the units of pressure should be psia in all cases, to prevent confusion concerning the barometric pressure which may exist at the location of the equipment. (5A.217)

The maximum allowable pressure loss for each stream, in the same units used for the inlet operating pressure. (5A.218)

To prevent confusion, the following should also be covered (5A.219):

The area which will be used for the determination of the coefficients of heat transfer which are guaranteed. (5A.219)

The correction factors which are applied to the logarithmic mean temperature difference in multipass units. (5A.2192)

The "fouling factors" or other means of correcting for loss of heat transfer efficiency with service. (5A.2193)

It is to be understood that the thermal design conditions are to be met when the unit is in a "fouled" condition. The fouling resistance employed in the design should be agreed upon, as indicated in 5A.2193 above. (5A.22)

It is generally understood that the condenser must perform satisfactorily in a "fouled" condition, even though it is expected that most tests will be performed on a relatively clean unit. In other words, the manufacturer must provide sufficient safety factor to account for normal fouling in service.

In general, it should be considered that the heat transfer coefficient should lie between the "clean" and "fouled," or "service," coefficient, as given by the manufacturer, for the equipment to be considered to have performed satisfactorily. (5A.222)

The manufacturer's guaranteed maximum pressure losses are under-

stood to be based on clean tube operation. Clean tube operation is understood to be operation immediately after the unit has been cleaned as outlined under 5.21, or immediately after installation. Pressure losses are also understood to include the entrance and exit losses of the connections. (5A.23)

(See 5A.221 and 5A.222 above.) Clean tube pressure losses are specified since the effect of fouling upon pressure loss is less well established than the effect of fouling on heat transfer coefficients. In general, no "fouling factors" have been developed for pressure loss. (5A.231)

Test Procedure. The performance test should be run under design conditions, if possible. Condensers are usually designed to operate under worst process conditions and cooling medium temperatures, and with some allowances for fouling. However, since it is seldom possible to test a condenser in the plant under the exact design conditions, the test results must be analyzed and interpreted to determine whether the condenser would operate satisfactorily under the designed conditions. Assuming that all temperature flow and pressure measurements have been properly made, there are still uncertainties in the interpretation of the test results. (5A.31)

The analysis of data requires knowledge of the active condensing area, the effect of vapor velocity, drop-wise or film condensation, mass diffusion, tube orientation and layout, and temperature gradient. The first item includes the fact that the active condensing area is affected by the presence of inert gas in the unit. The purchaser and the manufacturer should agree concerning the method which will be used to vent the unit.

There is further difficulty in condensers in the fact that a fouling resistance is difficult to measure by the operation of the condenser. The only reliable test procedure that can be established for the rating of condensers is to have the test performed when the condenser is "clean," and with the vapor composition as specified in the design conditions. It would then be necessary to make a specific calculation to determine the pressure and temperatures to be expected when the unit is in a "fouled" condition. If these conditions are met or bettered during the test, it could be assumed that the unit has been satisfactorily designed.

If it be impossible to duplicate design conditions, the test should be conducted under the attainable conditions which have been mutually agreed upon by the purchaser and manufacturer at the time of test. These conditions should be as near the design conditions as possible.

Cleaning of Condensers for Acceptance Test. It is desirable that tests made in connection with acceptance of equipment be performed as soon after initial operation as possible. When it is not possible to test the equipment immediately after initial operation, complete cleaning prior to test should occur. (C.f. 5.21) (5A.41)

6. Computation of Results. All data taken during the performance test should be averaged and the average values used for all computations. No performance test should be considered satisfactory, except under unusual conditions, unless the criteria given in 5.1 are met. (6.1)

The heat transferred should be calculated both for the cooling medium and the stream which is condensed. If the test data permit both calculations, (in many commercial installations it is not possible to obtain adequate test data for both streams) the two heat quantities should check within 10 percent of the smaller value if the test is to be considered reliable. (6.2)

The calculation of the average, or mean, temperature difference is the most uncertain portion of the calculation of the results of a performance test on condensers. Reference should be made to the literature[7,8] on this subject. (6.3)

The heat transfer coefficient calculated is the over-all coefficient. Normally the test data obtained do not permit the direct calculation of the film coefficients. The estimation of the film coefficient for the cooling medium may be made by means of the standard equations.[9] The condensing film coefficient should *not* be calculated using this value since the resistance due to fouling is unknown, *except* when the condenser is new, or has just been properly cleaned. (C.f. 5.21) (6.4)

7. Interpretation of Results. As pointed out in 6.4 above, the only heat transfer coefficient normally obtained with any degree of accuracy on commercial equipment is the over-all coefficient. Since the two streams affect this coefficient in different ways, it is difficult to adjust this value to some standard basis. This is especially true since the accuracy of estimating this effect of different variables upon the condensing film coefficient is not high. (7.1)

Since it is possible to estimate a liquid film coefficient with reasonable accuracy[9] adjustment may be made to bring this variable to a standard basis. This technique may be used to estimate a value of the condensing film coefficient *plus* all fouling resistances. (7.11)

Over-all Error. It is desirable that the error in determining the over-all coefficient should be within plus or minus 10 percent and that this error be distributed between the error in the determination of thermal properties and of flow and temperature measurements. Each of these quantities is involved in determining the heat which is transferred, which, with the temperature difference, is required to calculate the over-all coefficients. It is considered desirable that the heat and material balances for both streams should have an error within plus or minus 5 percent. (7.2)

Various methods of determining these quantities are outlined in Sections 3.4 and 3.5, together with an estimate of their accuracy.

LITERATURE CITED

[1] A.S.M.E., Power Test Codes, "Instruments and Apparatus," Part 3, Temperature Measurements, Chapter 1.
[2] *Ibid.*, Chapter 3.
[3] *Ibid.*, Chapter 6.
[4] Transactions of A.S.M.E., Volume 71, No. 7, Pages 871-883 (1949).
[5] Boelter, Cherry, Johnson, Martinelli, "Heat Transfer Notes," University of California Press, 1946, Chapter 8.
[6] Cichelli, *Industrial and Engineering Chemistry*, 40, Pages 1032-1039 (1948).
[7] Gloyer, *Industrial and Engineering Chemistry*, 42, Page 1361 (1949).
[8] McAdams, "Heat Transmission," Third Edition, McGraw-Hill, 1954, Page 332.
[9] *Ibid.*, Chapter 9.
[10] *Ibid.*, Chapter 13.
[11] Schoenburn and Colburn, Transactions of A.I.Ch.E., 35, Pages 359-380 (1939).
[12] Stearns, Jackson, Johnson, Larson, "Flow Measurement with Orifice Meters," VanNostrand, 1951.
[13] Standards of Tubular Exchanger Manufacturers Association, Third Edition, 1952, Page 85 et seq.
[14] "Temperature, Its Measurement and Control in Industry," Rheinhold, 1941, Page 240.

See next page for the complete text of standards . . .

How to Test Condensers . . .

Complete Text of Standards

(Parts 1-4)

1. Purpose and Scope

1.1 Purpose. The primary purpose of the Testing Procedure is to provide a Standard Procedure to be used to conduct performance tests of shell and tube type condensers under any set of operating conditions. (1.11) Thus this Testing Procedure may be used to obtain full scale test data to

1.111—Determine performance,

1.112—Compare predictions from theoretical heat transfer equations with commercial performance,

1.113—Compare results of theoretical pressure drop calculations with commercial performance,

1.114—Accumulate data on fouling resistances,

1.115—Provide information to assist the design engineer to provide the necessary test connections so that complete performance tests can be readily made.

A secondary purpose of this Testing Procedure is to provide standard directions for conducting performance tests of shell and tube type condensers for comparison with the manufacturer's predicted performance. It is not the intent of this procedure to establish any limits for permissible deviation between the actual performance, as indicated by the tests, and the manufacturer's predicted performance. Any such limits, or penalties for performance below them, should preferably be specified in the purchase contract. (1.12)

Although it is desirable to conduct performance tests on all equipment purchased, such tests are primarily required when the purchaser considers that the performance of the equipment is, or will be, unsatisfactory. The completeness with which these performance tests are carried out will depend upon the expense involved as well as the value of the equipment.

Scope. The scope of this Testing Procedure is limited to heat transfer in shell and tube type condensers, which by definition are exchangers in which condensation occurs on one side without change of phase of the cooling medium on the other. It is intended to include condensers in which the condensate is subcooled. It is not intended to include power plant type surface condensers, as these are adequately covered by the A.S.M.E. Test Code "Steam Condensing Apparatus," published in 1938. This Testing Procedure does not cover the methods of calculation to be used to determine the criteria of satisfactory performance for acceptance tests. (1.2)

2. Definitions and Description of Terms. All terms used in this Testing Procedure, with the exceptions noted below, are in accordance with accepted usage.[10] (2.1)

The exceptions to standard usage are: (2.2)

"Clean Coefficient." This means the over-all heat transfer coefficient which is obtained when only the two film coefficients and the tube wall are considered. (2.21)

"Fouled Coefficient" or "Service Coefficient." These terms are synonymous, and are used to describe the over-all heat transfer coefficient which includes the two film coefficients, the tube wall and the "dirt factor" or "fouling factor" applicable to each side of the tube wall. (2.22)

"Dirt Factor" or "Fouling Factor." These terms are synonymous and mean resistance to heat transfer caused by the dirt or fouling on the surface of the tube which accumulates during use. In many cases standard values of the fouling factors, which are considered "good practice," can be found in the literature.[10] (2.23)

3. Establishment of Test Conditions. Provisions should be made to obtain the data outlined below, during the course of performance tests. Methods of measurement for those items of data which must be collected during the test, together with suggestions concerning sampling procedures are covered in 4. (3.1)

The identification of all major components of each stream, i.e., both the stream to be condensed and the cooling medium, as to their essential physical properties, in both the liquid and the vapor phase for the stream to be condensed; namely, specific gravity, thermal conductivity, and viscosity, the last at least at two temperatures. Any special physical properties, e.g., pour-point of the stream to be condensed, should be covered. The specific heat of the cooling medium should be included. (3.11)

An equilibrium, cumulative, condensation curve (a plot of the amount of vapor condensed versus temperature) based on the actual composition of the stream to be condensed. This plot should apply to a specific pressure, preferably the inlet pressure. If it be expected that there will be a substantial pressure drop through the condenser, the effect of pressure upon the condensation curve should be included. (3.12)

A curve of total heat, or enthalpy, versus temperature should be developed from the condensation curve covered in 3.12 above. If the pressure drop through the condenser is expected to be large, additional curves should be developed giving the effect of pressure upon the enthalpy. If there be an appreciable heat of mixing upon condensation, data concerning this should also be included. (3.13)

The flow rates of the major components of each stream, including the amount of each component that is to be condensed from the vapor stream. (3.14)

The terminal temperatures of all streams (for each phase, if more than one exists). (3.15)

The total heat transferred. (3.16)

The inlet and outlet pressure for each stream. It is suggested that the units of pressure be psia in all cases, to prevent confusion concerning the barometric pressure which may exist at the location of the equipment and the time of the test. (3.17)

Information concerning the operating history of the equipment subsequent to the most recent cleaning, together with the cleaning methods employed. (3.18)

Complete engineering information concerning the design of the condenser. (3.19)

Precautions should be taken to see that the unit is internally tight at the floating head and tube joints, that it is externally tight at the floating head cover in the case of units in vacuum service, that it is properly piped up and all pipe joints are tight, that all by-passes, where provided, after being checked for tightness, are closed, and that the cooling medium side of the unit is thoroughly vented and running full. In the case of condensers in vacuum service, care should be taken to avoid pockets in the bottom of the condenser, or in lines from the condenser where condensate may be trapped. (3.2)

Care should be exercised to install temperature and pressure measuring instruments in accordance with methods outlined in the sections which follow. Temperature measuring instruments intended to give vapor temperatures in regions where condensate is likely to be present should be shielded or otherwise protected from possible contact with the liquid; whereas instruments intended to give condensate temperatures should be positively immersed in the liquid. In the case of partial condensers, the temperature of both the condensate and residual vapor should be measured. (3.3)

Lines from pressure taps to pressure gages or manometers should be installed in such a manner that the hydrostatic head in them remains constant. In determining pressure drops for condensers, especially for those in vacuum service, it is preferable to measure the differential across the condenser instead of absolute pressure at each terminal, since, in general, the pressure drop on the condensing side of a condenser is normally low. Especial care must be taken in the case of vacuum condensers, particularly when there is any substantial sub-cooling of the condensate. The method by which pressure is controlled at the outlet of the condenser may have a major effect on the measured pressure loss across the condenser (3.4)

4. Method of Measurment

Measurement of Temperatures. Source of Errors. Although the temperature measuring instrument may give accurate readings, temperature measurement errors may arise from other causes, such as transfer of heat from the point of measurement by conduction along the thermocouple or thermowell and by radiation between the thermowell and the surroundings, stratification in the fluid stream due to incomplete mixing or to improper separation of vapor from condensate in the case of mixed phase flow, fouling of the thermowell, partial failure of electric leads between the sensitive element and the instrument, and condensate drippage on the thermowell. (4.11)

Preferred Method (4.12). An accurate determination of the over-all heat transfer coefficient requires that both the heat transfer load and the mean temperature difference be computed accurately. An error of less than 5 percent is desired for each of these quantities; therefore, the temperatures should be measured with such accuracy that the maximum over-all error of the temperature difference is less than 5 percent (4.121)

Errors due to conduction losses are reduced by making the thermowell as long as possible, of a material of low thermal conductivity and with the cross-sectional area as small as possible. The thermowell should not extend more than one inch beyond the outside of the pipe and should be well covered with insulation in order to reduce the temperature gradient between the base and the tip of the thermowell. For instance, to measure to within 0.2 F., the temperature of a liquid flowing through a pipe covered with one inch of insulation, it is necessary that a ¼-inch steel pipe thermowell not extend beyond the outside of the pipe wall and that its length be a minimum of 6 inches for liquids in the neighborhood of 200 F. and 12 inches for liquids near 950 F. The error would be greater with gases than with liquids, unless condensation occurs. For methods of calculating these errors, see References 5 and 6. The thermowell should extend to the center of the pipe, and when the length of the thermowell approaches the radius of pipe, the well should be placed through a tee and extended into the pipe. It should be noted that installation of the thermowell through a tee is desirable in all cases. This method has the advantage of getting good immersion as well as tending to increase the velocity of the fluid passing it. To reduce the error of measurement as well as the time lag between the thermocouple reading and the fluid temperature, it is desirable to have the thermocouple in good thermal contact with the thermowell. If the system is such that a bare thermocouple junction can be in direct contact with the fluid, this is even more desirable. Care must be taken to prevent a volatile liquid from entering the thermowell and causing a false reading due to wet bulb evaporation effect. The same precautions apply when using thermometers of any type. For further details of installation of thermowells, see References 1, 2, and 3. (4.122)

Radiation errors are encountered only when measuring gas temperatures and may be reduced by the use of shields, high velocity thermocouples, and well-insulated walls. For further details, see Reference 2. (4.123)

Errors due to stratification in the stream may be reduced by the use of properly designed mixing chambers. These chambers are suitable for use only with single phase fluids. Mixing chambers will be needed primarily in the cooling medium stream from condensers and in the condensate from the condensers. A mixer consisting of four half-moon baffles placed one diameter apart in the pipe line or one of equivalent effectiveness, should be used. Better mixing is obtained if the baffles are rotated so as also to give the stream a twist. The thermowell should be installed two pipe diameters downstream from the last baffle and be located in the center of the pipe. In case the fluid is in laminar flow, then the baffle spacing should be decreased to bring the fluid into turbulent flow in the baffled section. A similar mixing chamber should be used ahead of the thermowell on the inlet line to the condenser, if there exists a possibility of nonuniform temperature distribution in the inlet line. All lines between the condenser, the mixing device, and the thermowell should be well insulated. The insulation should extend at least one foot beyond the downstream side of the thermowell. (4.24)

The temperature of the condensate and the vapors leaving a condenser should be measured separately and as close to the discharge end of the condenser surface as possible. To obtain the dry bulb temperature of the vapors is difficult and no really satisfactory method has yet been devised. The principle problem is to eliminate the entrained spray from the vapor so that the temperature measuring element is dry, since otherwise the spray will wet the thermowell and result in a wet bulb temperature measurement. It should be noted that, in general, the temperature of the vapors will be significantly higher than the liquid condensate temperature, although it is not believed that it would be strictly correct to state that the vapor was superheated. The dry bulb temperature may be closely approximated if the vapors are passed through a venturi at the throat of which a small amount of vapor is withdrawn for the measurement of the temperature. It should be noted that this technique should be used with care, since the decrease in pressure may result in a decreased vapor temperature from the expansion. Another alternate device is to employ a small liquid separator similar to a cyclone as a means for obtaining dry vapors. (4.125)

All thermowells should be removed or inspected before making a test in order to be sure that there is no deposited insulating material on them that would result in erroneous measurements. (4.126)

The temperature may be measured by means of resistance thermometers (resistance bulbs), thermocouples, mercury-in-glass thermometers, or bimetallic dial thermometers. Although these are listed in order of decreasing accuracy, the use of thermocouples is preferred due to their ruggedness, simplicity and ready availability in commercial installations. Before use, all thermocouples or thermometers that are to be used in a given test should be calibrated against each other and preferably over the temperature range in which they will be used. The purpose of the calibration is to insure the accurate determination of the temperature difference and not necessarily the accurate determination of the absolute temperature. The calibration can be made by placing the thermocouples or thermometers in a vapor bath, or in a well-stirred and insulated liquid bath, see Reference 3.

To provide against a shift in calibration, all measurements should be made within a period of three months, or the thermocouples should be check-calibrated at the end of each three-month period. Thermocouples and their leads should be made from standardized thermocouple wire. Where external cold junctions are used, they should be placed in a Dewar flask filled with chipped pure ice and pure water, and all cold junctions should be separated. To insure that the cold junction bath is at the ice melting point, a thermometer should be installed adjacent to the junctions.

The thermocouple e.m.f.'s should be measured with potentiometers capable of giving the accuracy required. Single junction base metal thermocouples can be made to read temperatures within 0.4 F., but if greater accuracy is required, multiple junction or differential thermocouples should be used. Where more than one thermocouple is to be used with a given potentiometer, connections between a couple and the potentiometer should be made through double pole, multiple throw switches. When thermocouple tips are grounded against the thermowell or the pipe, precaution should be taken that there are no stray currents or potentials to interfere with the thermocouple reading. (4.127)

Glass thermometers should be carefully handled and properly used. The appropriate correction for stem immersion should be made. Since slight changes in the thermometer bulb dimensions occur with time, which will cause the reading to drift, it is necessary to check the thermometer calibration every several months when precise readings are required. Limits of accuracy of thermometers are given in Reference 14. Calibration of bimetallic thermometers is affected by hysteresis of the bimetallic element and these thermometers should be avoided if possible.

Alternate Methods (4.13). When the preferred method cannot be used, then the methods described below can be used, but only when the flow in the lines is turbulent. However, the errors of measurement will be greater due to the temperature gradients present with imperfectly insulated walls. In viscous flow there is a definite temperature distribution in the lines and special mixing devices are necessary. (4.131)

Where mixing chambers cannot be placed in the pipe lines, errors are possible in measuring the temperature, since the fluid near the heated surface will be at a higher temperature than the main body of the fluid and thermal gradients will exist for considerable distances downstream even when the flow is turbulent through an intervening adiabatic zone. Therefore, the thermowell should be installed at least three to five pipe diameters from the heat exchanger. To check upon the completeness of mixing, a second thermowell should be installed at least ten pipe diameters from the exchanger, and preferably after a bend in the pipe line. The pipe lines should be well insulated between these points and allowances must be made for the heat loss. The probable error of measurement due to incomplete mixing is a function of the conditions under which the exchanger operates. The error in measuring the fluid temperature of a stream may be as much as 15 percent of the temperature difference existing between the two streams at the point in the exchanger where the fluid leaves the equipment. (4.132)

Where the dry bulb temperature of the vapor leaving the condenser cannot be correctly measured, a thermowell should be installed in the vapor line and the temperature reading should be considered a wet bulb temperature. However, it is still necessary to measure the condensate temperature separately. (4.133)

When the preferred thermowell length is greater than the pipe radius and a tee

connection as described in 4.1222 cannot be made, then the thermowell should be installed vertically, extending to the center of the pipe, the projection of the thermowell outside the pipe being reduced to the minimum possible length, and extra thicknesses of insulation being placed on the pipe for a distance of at least one foot on each side of the thermowell. These precautions will reduce the temperature gradient between the base and the tip of the thermowell. Thermowells may be omitted and thermometers and thermocouples may be inserted directly in the stream if the fluid conditions will permit such an installation. (4.134)

Where thermowells cannot be installed in the pipes, the thermocouples may be peened, soldered, or otherwise firmly attached to the wall. The junction leads should be wrapped around the pipe and taken away at a point opposite the junction. The above instructions for locating the thermowells also apply to locating the thermocouple junctions when they are attached to the pipe wall. The pipe should be covered with extra thicknesses of insulation which should extend at least two feet beyond the junctions on each side, in order to reduce heat losses and conduction errors. Thermocouples should be mounted at the top, the side and the bottom of the pipe at each location, in order to make allowances for thermal stratification. The probable error of temperature measurement is again a function of the conditions under which the exchanger operates and of the flow conditions in the pipe lines. Due to surface heat loss and to incomplete mixing, the error in measuring the fluid temperature may be as much as 25 percent of the temperature difference existing at the point in the exchanger where the fluid leaves the equipment. (4.135)

Measurement of Flow Rates (4.2).

General (4.21). Since most of the heat transferred in a condenser is the result of the latent heat of condensation, and since the cooling medium is normally relatively large in amount, with a relatively small temperature rise, the most significant measurements of rate of flow are on the condensing side of the equipment. (4.211)

Although the statement in 4.211 above will cover the largest proportion of the cases which will arise, the measurement of the rate of flow of the coolant will be of importance under certain circumstances. In those condensers which are primarily vapor exchangers, the temperature rise of the coolant may be of sufficient magnitude that the determination of the heat transferred may be accurately made. In addition, it is desirable to have a check on the duty calculated from both the stream to be condensed and the cooling medium, if this be possible with the instruments which are available in a particular setup. (4.212)

The measurement of the rate of flow for condensing equipment falls into several categories—(a) Where single phase streams can be measured by conventional means, i.e., when volume and allowable pressure drop will permit (see 4.22); (b) Where single phase streams cannot be measured by conventional means (see 4.23); and (c) Where the stream consists of two phases (see 4.24). (4.213)

Since the rate of flow represents one of the two factors in the determination of the heat transferred, the accuracy of the measurement of flow is of equal importance with the measurement of temperature. Therefore, every precaution should be taken to prevent error in this measurement as well. (4.214)

Single Phase Streams—measurable by conventional means. (4.22)

The rate of flow can be measured by means of instruments such as orifice meters, venturi meters, rotameters, displacement meters, or by direct volume or weight measurement. Whenever possible, the instruments should be calibrated in place, with the fluid to be measured, and at the temperature at which the fluid will be measured. (4.221)

Orifice meters have been extensively investigated and their performance can be accurately predicted for a wide variety of conditions. A properly installed orifice meter can be read to within an error of 2 percent. When other instruments cannot be calibrated in place, orifice meters are suitable. Details concerning the construction, installation, and calibration of orifices and nozzles can be found in the literature.[12] (4.222)

When rotameters cannot be calibrated in place, the theory developed by Schoenburn and Colburn[13] may be used to convert the calibration from one fluid to that for another, as well as for making corrections for variations of temperature and pressure. In using rotameters it is essential that the float and the tapered calibrated tube be kept clean. (4.223)

The direct methods of determining flows are either to weight or to measure volumetrically the fluid in tanks or gas holders over given time intervals. The scale or the tanks or gas holders which may be used in one of the direct methods should be carefully checked and measured, or preferably calibrated, to determine the exact relationships in order to reduce the error of the measurement. (4.224)

Single Phase Streams—not measurable by conventional means. (4.23)

This section is applicable to those conditions where, from pressure drop considerations, extremely large or small volumes, or others, it is impractical to use the methods outlined in 4.22, e.g., the vapor inlet to condensers or the liquid outlet from dephlegmators. (4.231)

When the vapor stream to the condenser is only partially condensed in passing through the equipment, and the vapor and liquid outlet streams can be measured by one of the methods outlined in 4.22, a simple material balance around the condenser will give the inlet stream. (4.232)

A suitable component may be added to either the vapor or the liquid stream at a measured rate. Analysis after complete mixing has taken place, will permit accurate estimation of the flow rate of the stream to be measured. In the case of the vapor stream, care must be taken in the selection of the component to prevent any effect on the performance of the condenser under test. If this be impossible, flow rate determinations must be made both before and after the temperature and pressure measurements. The rate may be calculated by:

$$X = b\left(\frac{1-a}{a}\right)$$

where

X = flow rate of stream

b = flow rate of added component (in consistent units with those used for X)

a = fraction of added component in mixed stream (4.233)

A careful heat and material balance around the system of which the condenser is a part will give an approximation of the flow rate of the vapor going to the condenser. This method may result in poor accuracy and should be used only as a last resort. (4.234)

The Stream to be Measured Consists of Two Phases (4.24).

This condition exists whenever total condensation does not occur in the condenser under test. This situation exists, therefore, in all condensers where measurable amounts of non-condensable exist, as well as in the so-called, "partial condenser." Normally, immediately downstream of the condenser, a separation is made between the condensate and the uncondensed vapors. The two phases can then be measured separately by one of the methods in 4.22 or 4.23, above (4.241)

When the vapor phase of the two-phase stream is totally condensed in other equipment, downstream of that under test, the condensate can be measured, by the methods outlined in Sections 4.22 and 4.23 above, after such total condensation. (4.242)

In the case of multicomponent mixtures, it is possible to estimate the rates of two of the three streams, i.e., inlet vapor, outlet vapor, and outlet liquid, from the rate of one and the compositions of all three streams, if the equilibrium relations between the liquid and the vapor are known for all components. (4.243)

Sampling Procedure (4.3).

When vapor samples are taken care must be used that no line condensate is included in the sample. If possible, only single-phase streams should be sampled, since it is virtually impossible to obtain simultaneous liquid and vapor samples in "line" ratios, or without contamination of one with the other. (4.31)

When taking liquid samples, care should be exercised to prevent the entrance of vapor into the sample line. This can be conveniently done by means of a seal loop in the line, if it be possible to install a sample connection below a liquid surface. (4.32)

When taking vapor samples, the sample connection should extend into the center of the pipe, preferably from the top, and have its opening headed downstream. This will minimize contamination of the sample with liquid. The sample line should be arranged to reduce condensation to a minimum until the vapor has a downward path to the sample condenser. (4.33)

##

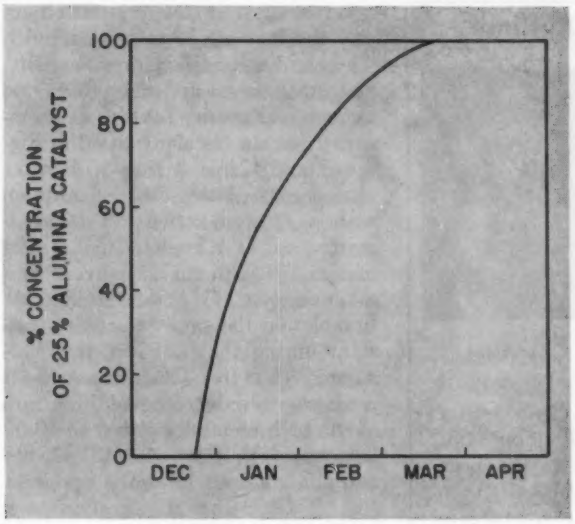


FIGURE 1—It took about three months for the high alumina catalyst to replace the older catalyst.

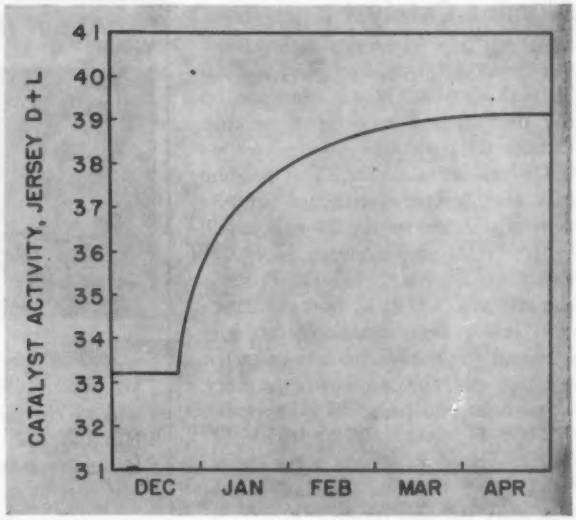


FIGURE 2—Even with a lower catalyst addition rate, the high alumina catalyst increased activity.

Cracking With High Alumina Catalyst

This refinery switched its fluid catalytic cracking unit to 25 percent alumina catalyst. Here are the results.

R. W. Roquemore and C. D. Strickland
Humble Oil & Refining Company
Baytown, Texas

THE STUDY reported here shows commercial scale fluid catalytic cracking of uncontaminated gas oils with 25 percent alumina catalyst provides a change in product distribution relative to cracking with 13 percent alumina catalyst. The high alumina catalyst produces more C_5-430 F. naphtha at the expense of butane and lighter products, and retains a higher activity. At the same equilibrium catalyst activity level, a 50-60 percent reduction in catalyst makeup rates could result with the higher alumina catalyst.

Because of the changing nature of the gas oil feed, it was impossible to determine whether the high alumina catalyst was more resistant to contamination. Nevertheless, the 25 percent alumina catalyst resulted in lower stack losses through a mechanism which is not fully understood.

A trial run on high alumina catalyst was carried out at the Baytown refinery of the Humble Oil & Refining Company. The unit selected for the catalytic cracking test run carries a circulating catalyst inventory of 220-250 tons and has a nominal feed rate of 52,000 barrels per stream day. This unit is one of the original "upflow" type fluid units that has been expanded and modified but still retains the "upflow" features. Relatively clean gas oils prepared in combination atmospheric-vacuum pipe stills comprise the charge stock to the unit.

Prior to the trial of high alumina, the unit had been charging 13 percent alumina catalyst. Average inspections obtained on the fresh 25 percent and 13 percent alumina catalyst are compared in Table 1.

A test run began on December 22, 1955, and a three-month operating period was required for a complete replacement of the unit catalyst inventory. Before the high alumina additions were begun, the fresh 13 percent alumina catalyst makeup rate was being maintained at ten tons per day, and the equilibrium catalyst exhibited an activity level of 33.2 Jersey D + L. Stack losses were averaging 4.5 tons per day, and the catalyst inventory was being maintained constant by withdrawing equilibrium catalyst.

The change over to high alumina catalyst was made by changing the daily additions from low to high alumina catalyst.

Products that were sampled from the cracking unit during each yield test consist of a high pressure gas and a high pressure distillate stream, light and heavy heating oil streams, and a bottoms product stream. The coke yield was determined from regenerator flue gas Orsat analyses and regeneration air rate. All feed, air, and product flow rates were measured with recording flow meters.

Mass spectrographic analyses were obtained on the high pressure gas samples. The high pressure distillate samples were debutanized in a 25-gallon true boiling point distillation column and the debutanized bottoms were distilled overhead to a 430 F. end point. Mass spectrographic analyses were obtained on the gas from

the debutanization step, and a Podbielniak distillation was obtained on the debutanized overhead sample. Octane determinations were run on the overhead samples. The heating oils and bottoms product samples were distillated in the 25-gallon still to determine the amounts of 430 F. end point naphtha, 430-650 F. heating oil, and 650+ F. bottoms product. Octane determinations were also made on the naphtha fractions of the heating oils and bottoms product. Total light ends, C_5-430 F. naphtha, 430-650 F. heating oil, and 650+ F. bottoms product yields were calculated from the analytical data obtained by the above procedures.

An equilibrium catalyst activity level of 33.2 Jersey D + L was being maintained before the high alumina addition was begun. Average properties of the circulating catalyst are shown in Table 2. The alumina content averaged 13 percent. Surface area by low temperature nitrogen absorption averaged 120 square meters per gram, with a pore volume of 0.27 cubic centimeters per gram. The activity level was being maintained with a daily catalyst addition of ten tons or about a 4 percent of inventory replacement per day. This addition rate was continued after the switch to high alumina until January 28. On that date, it became necessary, because of reactor severity limitations, to reduce the daily addition rate to seven tons per day or about a 3 percent of inventory replacement per day. The addition rate was maintained at approximately seven tons per day for the remainder of the test period.

Figures 1 and 2 are chronological plots illustrating, respectively, the percent concentration of high alumina catalyst in the unit inventory and the increase in catalyst activity. The catalyst addition rates, activity, and stack losses for the test period are summarized in Table 3. It is evident from the data presented in Figure 2 and Table 3 that with three tons per day lower catalyst addition rate, a catalyst activity of approximately six D + L units higher was maintained with the 25 percent alumina catalyst. If it had been desirable to maintain the catalyst activity constant during the trial run, it is calculated that it would have been necessary to reduce the addition rate of the high alumina catalyst to 40-50 percent of that for the 13 percent alumina catalyst. It also is apparent from Table 3 that the catalyst stack losses were reduced appreciably after changing over to the high alumina catalyst. These lower stack losses were realized even though a section of the regenerator Cottrell precipitator catalyst recovery equipment went out of service early in January and remained out of service for the remainder of the trial run.

Product distribution was changed after the addition of high alumina catalyst was begun. These effects were determined from the nine yield tests that were conducted during the trial run. Several changes in feed stock quality and operating conditions occurred during the test program. These changes, although not large, were of such an extent to invalidate a direct comparison of the yield test data. However, the test data were adjusted to constant feed quality and operating conditions, and a comparison was then possible.

The product yields and qualities were plotted against the concentration of 25 percent alumina catalyst in the unit, and only those yields that exhibited definite trends with concentration were considered to have changed. This comparison indicates that, at the same operating conditions and with the same quality feed stock, the 25 percent alumina catalyst gives lower propane, propylene, iso and normal butanes, and pentane yields. It gives higher pentylene and C_6-430 F. naphtha yields. Essentially no change was noted in the carbon, butylene, 430-650 F. heating oil, and 650+ F. bottoms product yields. An increase in the percent unsaturation was found in the C_3, C_4, and C_5 frac-

About the Authors

Roquemore

Strickland

W. K. ROQUEMORE is senior chemical engineer for Humble Oil & Refining Co., Baytown, Texas. He has been assigned to the Process division as assistant general foreman in the Cracking and Polymerization department. Roquemore received both his B.S. and M.S. degrees from the University of Texas.

C. D. STRICKLAND is a junior chemical engineer at the Baytown refinery of Humble Oil & Refining Co. He received his B.S. degree in chemical engineering in 1953 from Louisiana State University, and shortly afterward joined Humble where he now uses electronic computers to solve cat cracking problems.

TABLE 1
Fresh Catalyst Inspections

	13% Alumina	25% Alumina
Chemical Analysis, Weight Percent:		
Percent Alumina (Al_2O_3)	13.27	25.44
Percent Silica (SiO_2)	86.53	74.36
Percent Sodium Oxide (Na_2O)	0.020	0.030
Percent Iron (Fe)	0.025	0.025
Percent Sulfate (SO_4)	0.15	0.40
Percent Loss on Ignition (1500 F.)	11.0	13.0
Particle Size Distribution, Wt. %:		
Screen, U.S. Standard Sieve:		
Percent on 40	0.0	0.0
Percent on 100	1.6	0.5
Percent on 140	5.4	2.5
Percent on 200	9.5	10.5
Percent Pass 200	83.5	86.5
Corrected Air Elutriation (C.A.E.):		
Percent 0-20 Nicrons	2.0	2.0
Percent 20-40 Microns	12.0	11.8
Percent 40-80 Microns	66.0	71.0
Percent 80+ Microns	20.0	15.2
Density, Pounds per Cu. Ft.:		
Compacted	37.0	36.5
Aerated (0.3 ft./sec.)	23.0	22.0
Activity, D+L:		
Pretreatment:		
3 Hours, 1550° F.	53.0	51.5
24 Hours, 1050° F.	31.0	36.3

TABLE 2
Representative Plant Circulating Catalyst Properties

Catalyst Type	13% Alumina	25% Alumina
Catalyst Addition Rate:		
Tons per Day	10.0	7.0
Percent of Unit Inventory	4.0	3.0
Pounds per Barrel, Fresh Feed	0.38	0.27
Stack Losses, Tons per Day	4.5	2.5
Activity, Jersey D+L	33.0	39.0
Physical Properties:		
Surface Area, square meters/gram	120	142
Pore Volume, cubic centimeters/gram	0.27	0.38
Emission Spectrograph Analysis, Weight Percent:		
Fe	0.14	0.20
Na	0.09	0.13
V	0.008	0.012
Ni	0.01	0.014
Ca	0.028	0.038
Cr	0.0019	0.0027
Particle Size Distribution:		
U.S. Standard Sieve, Weight %:		
Percent Held on 140 Mesh	3.7	1.8
Percent Held on 200 Mesh	5.3	3.2
Percent Held on 325 Mesh	50.0	42.0
Percent Passing 325 Mesh	41.0	53.0

tions. There were some effects on C_5-430 F. naphtha quality.

The Research clear and leaded and the Motor clear octane numbers remained constant; however, a decrease was indicated in the leaded motor number. Naphtha volatility at all temperatures decreased. The percent hydrogen in the coke yield remained constant. No effect was noted on the regeneration efficiency or on the CO_2/CO ratio in the regenerator flue gases.

To show the effect of the new catalyst on yield distribution, two comparisons have been made based on the indicated yield changes found from the test data. The first comparison was made at constant catalyst activity and the second at constant catalyst cost. High alumina catalyst costs 1.5 cents per pound more than the 13 percent alumina catalyst. As of mid-January 1957, the market prices for 13 percent and 25 percent alumina catalysts are 15.0 cents and 16.5 cents per pound, respectively. The operating conditions and product yields for the comparison are given in Tables 4 and 5.

Case I represents operations with 25 percent alumina catalyst when an equilibrium activity of 38 Jersey D + L is maintained. Case II typifies operations with 13 percent alumina catalyst with the same equilibrium activity as maintained in Case I; whereas, Case III represents 13 percent alumina catalyst operations when daily catalyst costs are kept the same as those in Case I. In all cases, the carbon yield is held constant.

More favorable catalyst selectivity is realized with 13 percent alumina catalyst in Case II because of the higher catalyst addition rate. Consequently, because of the constant carbon production limitation, a slightly higher percent conversion is realized than with the 25 percent alumina catalyst. In Case III where the catalyst cost for 13 percent alumina is the same as with the high alumina catalyst, no advantage in catalyst selectivity is believed to exist since with constant feed quality the contamination input per unit of catalyst surface would be approximately equal to that in Case I. Therefore, the percent conversion in Case III is the same as in Case I. It is seen from the above comparisons that the 25 percent alumina catalyst produces more naphtha than the low alumina catalyst, and it produced the incremental naphtha at the expense of light ends production. The incremental naphtha produced is of poorer quality than that produced with 13 percent alumina catalyst.

An economic evaluation of the attractiveness of this shift in yield structure and product quality is dependent upon the refinery limitations, the product demands, and the product price structure that may exist at any particular refinery. Such changes may be attractive to some refiners and unattractive to others.

ACKNOWLEDGMENT

The writers wish to express appreciation to the Humble Oil and Refining Company for permission to publish this article.

TABLE 3
Catalyst Usage During Trial Run

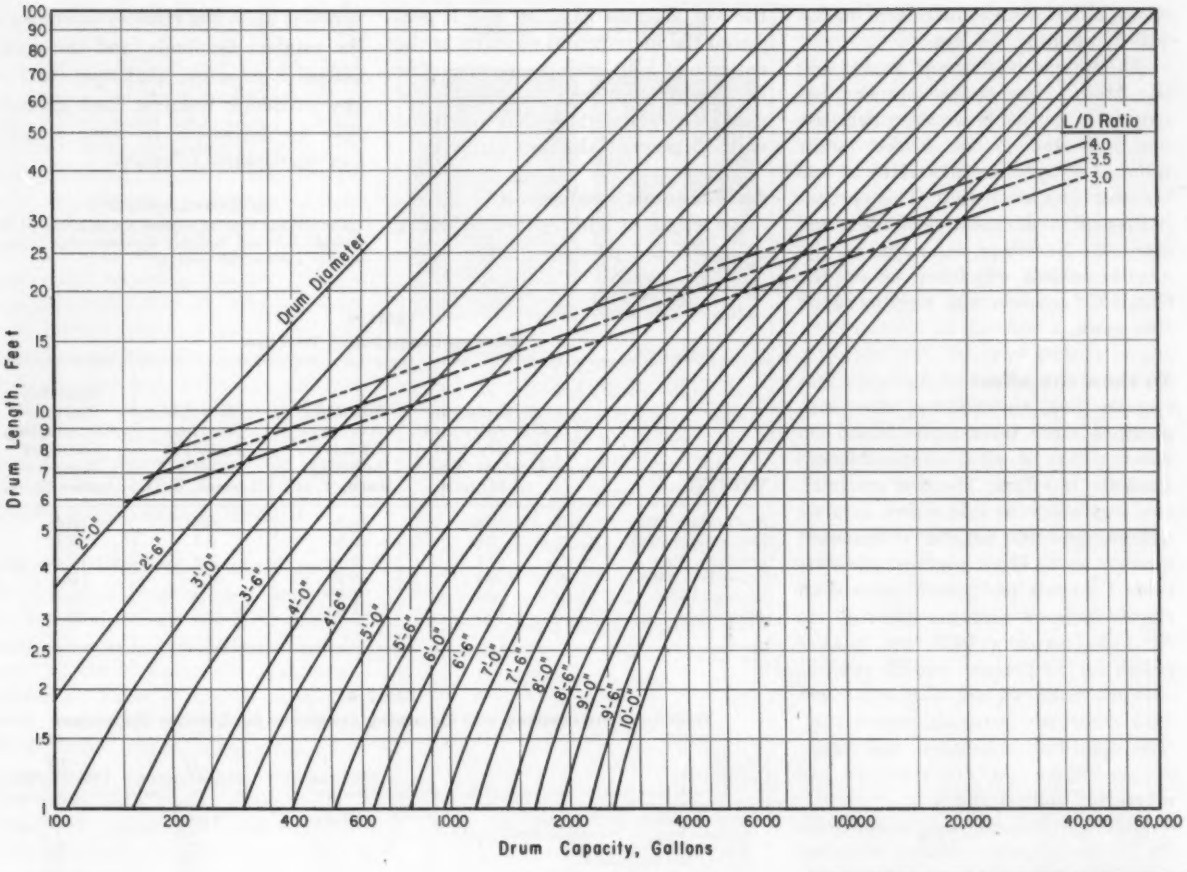
MONTH	% Conc. of 25% Alimuna Catalyst in Unit at End of Month	Monthly Average Catalyst Addition Rate, T/D	Monthly Average Catalyst Stack Losses, T/D	Monthly Average Circulating Catalyst Activity Jersey D+L
November, 1955	0	10.3	4.8	33.2
December, 1955	27	9.9	4.1	33.6
January, 1956	71	9.4	2.4	37.0
February, 1956	93	6.9	3.1	38.5
March, 1956	100	7.2	1.8	39.0
April, 1956	100	7.1	2.3	39.1

TABLE 4
Fluid Catalytic Cracking Unit Operating Conditions for Catalyst Comparison

Case No.	I	II	III
Catalyst Type	25% Alumina	13% Alumina	13% Alumina
Operating Conditions:			
Fresh Feed Rate, B/D	52,000	52,000	52,000
Bottoms Recycle, Percent on Fresh Feed	1.5	1.5	1.5
Reactor Top Pressure, psig	27.0	27.0	27.0
Reactor Temperature, F.	955	955	955
Carbon Burning Rate, pounds/hour	22,500	22,500	22,500
Catalyst—Oil Ratio (Total Feed)	6.7	6.7	6.7
430° FVT Conversion, Percent Total Feed	61.2	62.3	61.2
Catalyst:			
Addition Rate, tons/day	7.0	15.5	7.7
Activity, Jersey D+L	38.0	38.0	31.6
Carbon on Regenerated Catalyst, Wt. Percent	0.4	0.4	0.4
Surface Area, square meters/gram	136	136	108
Fresh Feed:			
Gravity, °API	27.6	27.6	27.6
Distillation, (ASTM 10mm Vac. Conv. to 760mm)			
10 Percent	586	586	586
50 Percent	753	753	753
80 Percent	885	885	885
Conradson Carbon, Weight Percent	0.15	0.15	0.15
Sulfur, Weight Percent	0.90	0.90	0.90
Aniline Point, F.	175	175	175

TABLE 5
Product Distribution for Catalyst Comparison

Case No.	I	II	III
Catalyst Type	25% Alumina	13% Alumina	13% Alumina
Yields, Percent on Fresh Feed:			
Dry Gas (C_2 and Lighter), Weight Percent	10.1	11.8	11.8
Propylene, Volume Percent	8.0	9.5	9.2
Propane, Volume Percent	3.1	4.3	4.0
Butylenes, Volume Percent	9.8	10.3	10.5
Isobutane, Volume Percent	4.6	6.8	6.0
Normal Butane, Volume Percent	1.5	1.8	1.7
Pentylenes, Volume Percent	7.0	5.1	5.3
Pentanes, Volume Percent	3.6	5.4	4.7
C_5-430 F. Naphtha, Volume Percent	44.1	40.3	39.5
430-650 F. Heating Oil, Volume Percent	22.9	22.5	23.0
650+ F. Bottoms Product, Volume Percent	14.3	13.7	14.4
Coke, Weight Percent (10 percent Hydrogen in Coke)	3.7	3.7	3.7
C_5-430 F. Naphtha Quality:			
Gravity, °API	57.5	57.9	57.4
Reid Vapor Pressure	6.4	6.7	6.5
Research Octane, Clear	93.9	93.9	93.9
Research Octane + 3 cc TEL	97.5	97.5	97.4
Motor Octane, Clear	80.5	80.5	80.5
Motor Octane + 3 cc TEL	84.5	85.4	85.4
Distillation, ASTM, Percent at 158 F.	28.4	31.2	30.2
Percent at 212 F.	42.7	48.0	47.1
Percent at 257 F.	58.9	66.0	65.4
Percent at 302 F.	71.3	80.6	80.3
Percent at 356 F.	85.3	92.0	91.9
430-650 F. Heating Oil, °API	25.6	23.1	23.4
650+ F. Bottoms Product, °API	22.8	19.1	19.9



Make Drum Sizing Easier

This chart eliminates trial-and-error methods in figuring dimensions for horizontal drums.

C. A. Petrarca
Foster Wheeler Corp., N. Y.

TO SIZE a horizontal drum with a certain capacity requirement and yet keep within certain limits of length to diameter ratio is a routine task. Often the problem is solved by trial and error.

This graph allows a drum to be sized quickly and easily with less than a 2 percent error. It is assumed the drum will have 2:1 elliptical heads.

Examples

Problem: Find the dimensions of a 2500 gallon drum having a length to diameter ratio of between 3 and 4.

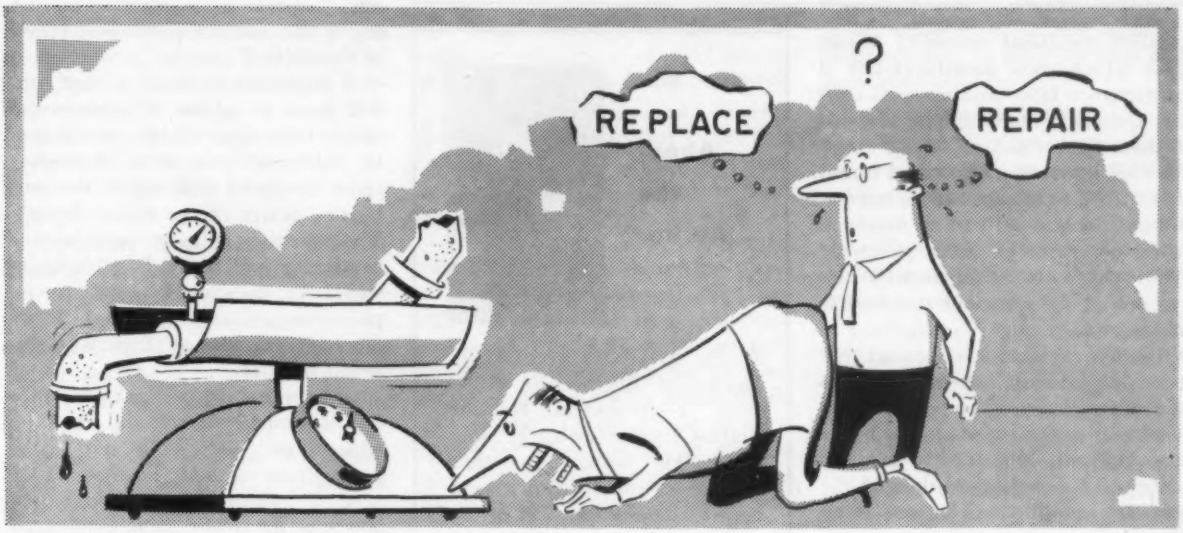
Solution: Enter the chart on the abscissa for a drum capacity of 2500 gallons. Read up to get combinations of diameters and lengths which will give this capacity, e.g. 6′-6″ x 8′-0″, 5′-0″ x 15′-6″, 4′-0″ x 25′-0″, etc. A drum of 5′-0″ diameter and 15′-6″ length would fall within the proper length to diameter ratio.

Problem: Find the volume of liquid in a 4′-0″ x 15′-0″ reflux drum which is half full.

Solution: Enter the chart on the ordinate for a drum length of 15′-0″. Move to the right for a drum diameter of 4′-0″. Then read down to get a total drum capacity of 1560 gallons. Since the drum is only half full it would contain only 1560/2 or 780 gallons.

About the Author

C. A. PETRARCA is senior process engineer for Foster Wheeler Corp., New York, where his duties involve process engineering of chemical treating units and catalytic desulfurization plants. Petrarca graduated from the University of Pittsburgh in 1951 with a B.S. degree in chemical engineering. Shortly after graduation he joined Foster Wheeler and was assigned to process designs of light ends distillation facilities. In 1952 he was transferred to the treating section of the Petroleum division where he is presently located.



New System for Maintenance Control

Here's a method that allows you to calculate the limits of tolerable maintenance so you will know when maintenance costs become excessive. This is done by using a new tool for maintenance control called wear points.

B. A. Margo
Montreal, Canada

DURING THE last few years there has been a growing interest in maintenance and replacement problems. Profitable operations depend more than ever on *measurable facts,* produced as quickly as possible. In the field of maintenance, this means that we want to be informed *immediately* if maintenance costs of any machine or other piece of equipment go out of line. We want to prevent excessive maintenance costs that occur and we want to know when replacements should be considered in order *to avoid excessive maintenance costs.* The maintenance control method developed by the author may be instrumental in answering these questions.

In refineries many pieces of equipment have to be replaced because they become unsafe. This does not preclude that maintenance costs may have already passed the limit as conceived under the method to be discussed. Other pieces of equipment are replaced because of the *savings* expected from a new one. Whenever such replacements are considered, a number of complex problems have to be solved, starting with an estimate of the savings obtainable and ending with a decision as to the return on investment to be desirable.

PART 1

The first section of this series will be devoted to a discussion of the maintenance control method, the second section to an explanation of the replacement control method.

MAINTENANCE CONTROL METHOD

This method has been developed while working on a planned maintenance setup in a large paper mill. We

installed the usual system of history cards which show monthly totals of maintenance labor and material costs per equipment number. The notation of these figures did not make much sense because it was a historical record only with the character of useless statistics so long as we had no means of evaluating them. At what point did these costs become "too high?" This was one of the questions that had to be answered.

Another problem was the fact that there did not exist any experience as to the frequency of inspections and overhauls needed for numerous pieces of equipment. No doubt, this frequency had something to do with the operating conditions. The next question then was whether operating conditions for any kind of machinery and equipment could be measured and expressed by figures. Consequently, a point system was developed for measuring operating conditions or wear, and this point system was used for calculation of limits of tolerable maintenance costs in dollars per month: the figure we needed on the history cards!

How to determine limits of tolerable maintenance costs. The three factors needed to calculate limits of tolerable maintenance costs are

1. Value of the unit to be maintained
2. Its operating conditions
3. The maintenance budget

Considering these three factors we can *calculate* when maintenance costs become excessive, which means that we can do in a systematic manner with as high a degree of accuracy as we wish what every good maintenance man tries to do *instinctively*. He is prepared to spend more money on a valve costing $500 than on one costing $50; more money on a valve in an acid line than on one used with clear, cold water. But he has to live within his budget! He has to draw the line somewhere, therefore, he looks at thousands of history cards which show him the amounts spent to find out when costs go "too high."

He may find at the end of the year that a certain unit started costing "too much" at the beginning of the year because it takes him too long to scan thousands of cards.

To decide instinctively what is "too high" is extremely difficult, if not hopeless, taking into consideration the complexity of the situation. This will become clear when we discuss the three factors in the following.

Value of unit maintained. We have a choice between "replacement" value and "original price adjusted according to the changed purchasing power of the dollar."

If replacement value is used, one will have to adjust all replacement values from time to time, which may be yearly or more often depending upon the speed with which the purchasing power of the dollar changes. This operation as such would be time consuming and costly. In addition, it would be difficult to ascertain replacement values of units which are not built anymore at all or with different features.

In contrast, the original price of a unit is normally known and has to be adjusted *once only*, at the start of the new control method. To this end we need a measure of the purchasing power of the dollar, some kind of index which is suitable for the purpose in question. This might be the Consumers' Price Index as published by the Bureau of Labor Statistics as per Table 1.

This table shows the Index numbers for the years from 1935 to 1956 and conversion factors with which prices of previous years may be adjusted to the purchasing power of the dollar in 1956. For instance, if the price of a unit in 1944 was $100, it might cost about 1.56 x $100 = $156 in 1956.

Using this method, we are not concerned with the question of whether an identical or equivalent unit is today available or not. We are only adjusting dollar values. Our only problem is to find an index which is an acceptable measure of the purchasing power of the dollar.

If and when the purchasing power of the dollar changes, we do not have to change our adjusted prices, since the calculation of our limits of tolerable maintenance costs (in the following abbreviated "limits") is based on the ratio

$$\frac{\text{Maintenance Budget in Dollars}}{\text{Total Investment in Dollars}}$$

If the maintenance budget has to be varied because of varying labor and material costs, we may assume that the total investment would vary in the same proportion. Consequently, the ratio would remain the same.

Here the expression "vary" has been used which requires an explanation. The maintenance control method we are discussing is univer-

TABLE 1
Consumer's Price Index

Year	Index No.	Conversion Factor	Year	Index No.	Conversion Factor
1935....	98.1	2.00	1945..	128.6	1.52
1936....	99.1	1.98	1946..	139.5	1.40
1937....	102.7	1.91	1947..	159.6	1.23
1938....	100.8	1.94	1948..	171.9	1.14
1939....	99.4	1.97	1949..	170.2	1.15
1940....	100.2	1.95	1950..	171.9	1.14
1941....	105.2	1.86	1951..	185.6	1.06
1942....	116.6	1.68	1952..	189.8	1.03
1943....	123.7	1.58	1953..	191.3	1.02
1944....	125.7	1.56	1954..	191.9	1.02
			1955..	191.4	1.02
			1956..	196	1.00

Note: The Index numbers up to 1952 are based on 1935-39=100, the consecutive numbers are based on 1947-49=100 but recalculated to the other basis. Therefore, they are only approximately correct. The Index number for 1956 has been estimated by the author.

About the Author

B. A. MARGO received his Doctor of Engineering degree from Technological Institute, Berlin-Charlottenburg, Germany. He worked for three years in Germany with a management consulting firm on the reorganization of several plants in the metals industry. He then became superintendent in charge of production, and later consultant and plant engineer of a machine tool factory. After moving to Canada, Margo worked for various companies as a consultant until he organized B. A. Margo & Associates, consulting engineer firm. He has been appointed consulting editor of *Plant Management and Maintenance*, a journal of Wallace Publishing Company.

sally *applicable to anything that has to be maintained,* machines, buildings, pipe lines, instruments, any kind of equipment, tankers, docks etc. The fact that it has been developed during a period of *increasing prices,* is a coincidence. Perhaps some of the readers will live long enough to experience a period of *decreasing prices.*

Operating Conditions. Table 2 shows various operating conditions and so called "wear points" which are a measure of these operating conditions. This is a specimen table only which may have to be condensed or enlarged to suit individual plant conditions.

Wear points may be determined with more or less accuracy as desired. In certain circumstances it may be sufficient to make an intelligent guess, using the judgment of good maintenance men and/or reliable maintenance records. In other circumstances it may be preferable to *measure* what happens, in the plant or in the laboratory. Such measurements too may be performed over longer or shorter periods of time, with more or less accurate measuring instruments. For *corrosion,* a great number of data are available which can immediately be used to establish wear points as will be explained later on.

In this connection we have to visualize that we are dealing with *cost accounting,* a phase of plant operation which is not a pure science but an auxiliary function which is supposed to produce results which are only as accurate as needed for the specific purpose, *not* as accurate as possible. This may be illustrated by the following example.

Let us assume that we want to find the consumption of light per month for the general office, the laboratory, the yards etc. To this end, we need the light bill and some kind of measure per department. A very rough approach would be to count the number of lighting fixtures per department. More accurate would be to establish the kw installed per department. Next we may feel that it would be better to know the number of kw-hrs consumed per department. This in turn could be accomplished by observation (occasional or permanent) of the hours of usage. Finally, if the accuracy is needed, we may decide to install light meters in each department.

In other words, wherever an approximate measure of light consumption is sufficient, the expense for installation and rental of light meters would not be justified and vice versa.

However, establishing of wear points is greatly simplified by the fact that the individual plant is *only* concerned with *relative values,* not with absolute ones. For instance, if we pick the machine with the largest vibration we find in a specific plant, we are not concerned with the possibility that there may exist somewhere else a machine with much stronger vibration, perhaps with the strongest vibration in the world, which would give us the largest value of wear points for vibration on an *absolute scale.* Such absolute scales may eventually be established and would simplify the task of setting wear points in individual plants. In the meantime, there is no limit to the ambitious plant engineer in using his own judgment and initiative.

TABLE 2
Specimen Table of Wear Points

Item No.	DESCRIPTION	OPERATING CONDITIONS	Wear Points
1	Usage	1 shift 2 shifts 3 shifts	1.0 2.0 3.0
2	Extra wear caused through change of operators	2 shifts 3 shifts	1.1 1.2
3	Extra wear caused through increased difficulty of maintenance	2 shifts 3 shifts	1.1 1.2
4	Load	Constant Slight fluctuation Continuous fluctuation Repeated shock	1.2 1.7 2.4 3.6
5	Vibration	None Slight Medium Severe	1.0 2.0 3.0 4.0
6	Stress	Small Medium High	1.1 1.3 1.6
7	Corrosion Note: For details see article No. 2 of this series.	Broken down into as many forms of corrosion as needed and degrees as follows: none slight medium severe	1.0
8	Abrasive content, abrasion	None Small Severe	1.0 1.2 1.6
9	Temperature fluctuation	Negligible Gradual Sudden	1.0 1.3 2.5
10	Velocity	Small Medium High	1.1 1.2 1.3
11	Use outdoors	Summer Winter	1.2 1.4
12	Treatment by operators	Good Bad	1.0 1.5
13	Importance of Unit	Non-critical Semi-critical Critical	1.0 1.2 1.4
14	Overload	Broken down according to duration and degrees	
15	Effectiveness of Maintenance organisation	High (preventive) Low	1.0 1.2

Explanations of Table 2

a—Operating Conditions. These are the conditions as existing at the time of installing the system and as assumed to be in existence for some time. This implies that normal efforts to improve operating conditions will be continued.

b—Choice of Operating Conditions. We have only to be concerned with operating conditions which are uniform for the whole plant and those which are *predominantly* responsible for wear or degradation of individual units. For instance, if a pipe line is obviously subject to severe corrosion, other factors as gradual fluctuation of temperature (item 9) might be negligible. This wear or degradation takes place despite the fact that the unit has normally been designed, built and installed with the intention to make it suitable to cope with the anticipated operating conditions—for a certain period of time. For instance, a pump is normally designed etc. to handle the volume, the pressure and the kind of material which it may eventually handle. Still, the same data will be responsible for its wear.

c—Limited Choice of Degrees. Table 2 shows a choice of up to four degrees of operating conditions only, e.g. for Item 5 "none," "slight," "medium" and "severe." This was done to simplify matters, but it does not mean that intermediate values should be avoided under all circumstances. However, it is advisable to define the meaning of these words in a manual so that subjective decisions may be reduced to a minimum.

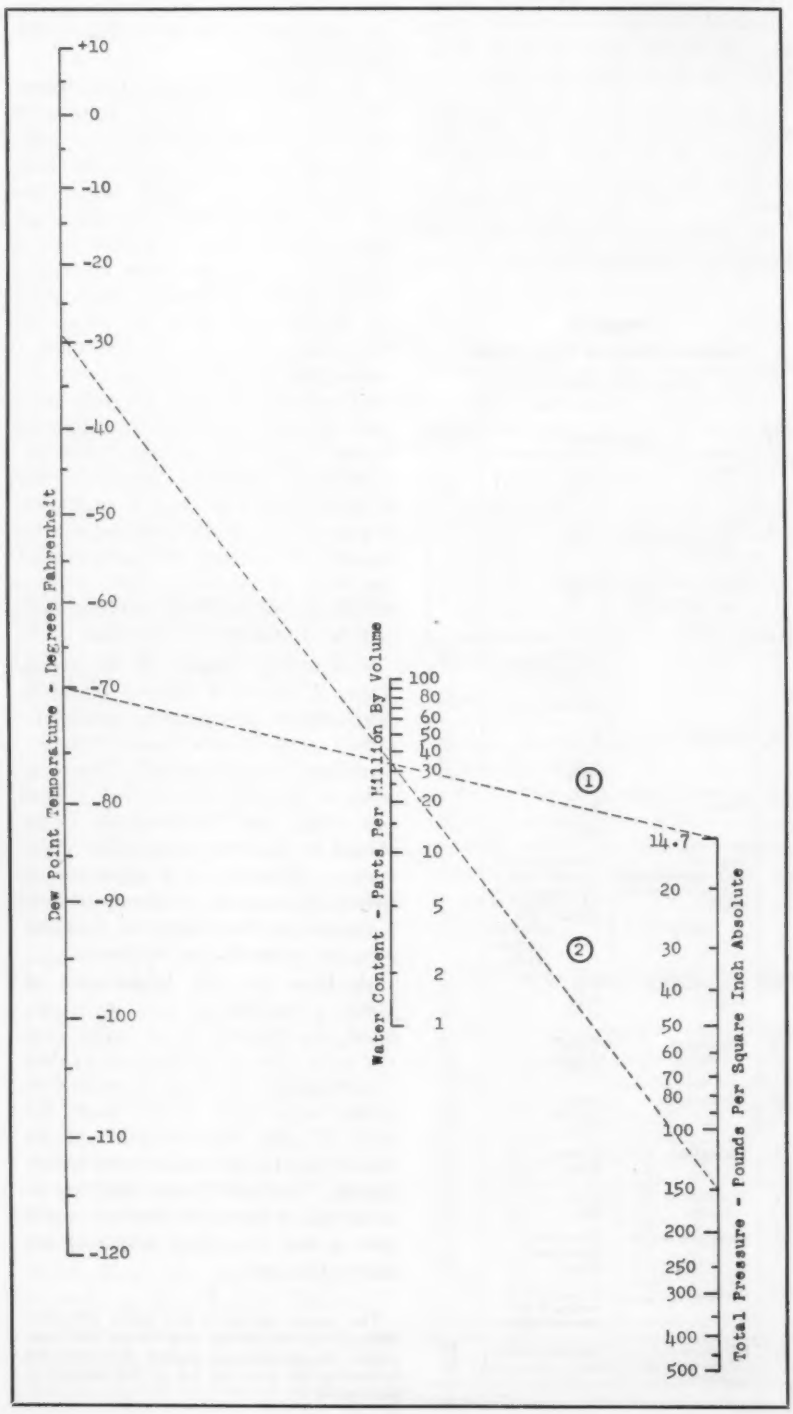
d—Item No. 13, Importance of Unit. A machine or piece of equipment, the breakdown of which does *not* cause a loss of production, is called "non-critical." If a loss of production would occur after a few hours, the unit is called "semi-critical"; if the loss of production would occur immediately, "critical." Doing this, we assume that a loss of production entails also a loss of money which is not always the case.

•

The second article in this series will cover methods for calculating wear factors and wear points, the maintenance budget, and examples indicating the practical use of this method in your plant.

Get Dew Points Easily

This handy nomograph may be used to get the dew point of a vapor at an elevated pressure.



Max F. Mueller
Grace Chemical Company
Memphis

THE DEW POINT temperature of an air-water vapor mixture is that temperature at which a given mixture of air and water vapor is saturated with water vapor. It is, therefore, the temperature at which the condensation of water vapor begins as the temperature of the mixture is reduced.

At sub-freezing temperatures the specific humidity of saturated air has been found to correspond to the vapor pressure over sub-cooled water whether the air is actually in contact with sub-cooled water or with ice. Ewell[1,2] in pointing this out, mentions that English and German Meteorological Services give tables in reference to undercooled water. Keyes and Smith[3] confirm this relation.

An example of the use of the nomograph follows. Suppose the dew point temperature in the effluent from a desiccant dryer has been measured to be —70 F. At atmospheric pressure, 14.7 psia, this may be seen from line 1 on the nomograph to correspond to a water content of 33 parts per million by volume. If the equipment is operating at 150 psia, then from line 2, it is determined that the dew point temperature at operating conditions is —29 F.

The nomograph may be used for determining the dew point temperature of any permanent gas other than air, as long as no condensibles other than water are present in the permanent gas. The relationship will not hold if gases are present which will react with water vapor for example, SO_2. The nomograph should not be used when the water content is reported in parts per million by weight.

LITERATURE CITED

[1] Ewell, A. W., Refrig. Eng., 27, 131-2 (March, 1934).
[2] Ewell, A. W., Refrig. Eng., 35, 176-7 (March, 1938).
[3] Keyes, F. G. and Smith, L. B., Refrig. Eng., 27, 127-30 (March, 1934).

Compare Finned and Plain Tubes

Several methods are suggested for comparing the heat transfer and pressure drop characteristics of heat exchanger tubes.

Merk Hobson
James H. Weber
University of Nebraska
Lincoln, Neb.

THE USE of extended surface equipment as the inner element of a concentric pipe heat exchanger is recognized as a means of increasing the heat transfer of an exchanger. A number of different types of extended surface equipment are available. The question then is: which type of extended surface is best to use under prevailing circumstances?

Heat transfer and pressure drop data are calculated for four concentric pipe exchangers; three employing different types of extended surfaces as the inner element and one, a plain tube. The performance of the various exchangers are presented in graphical form. The comparison of the heat transfer performances show the superiority of the extended surface equipment, while the comparison of the pressure drop characteristics show the advantage of the plain tube exchanger.

Both characteristics are combined then in a power performance factor. This factor shows that the plain tube exchanger is less desirable than either the transverse finned or continuous longitudinal finned equipment, but more desirable than the spined tube exchanger.

Fundamentally, there are two bases on which the performance of the various types of heat transfer equipment may be compared; namely, the heat transfer and pressure drop characteristics. If the heat transfer characteristics are considered first, it should be borne in mind that the amount of primary surface is reduced by the presence of the fins. Also the rate of heat transfer through the extended, or secondary, surface may not be as high as through the primary surface. The metal of the fin offers some resistance to heat transfer and therefore, there is a temperature drop over the length of the fin. This phenomenon has led to the development of the "fin efficiency" factor. Gardner[2] has calculated efficiencies for a number of different types of extended surfaces.

Fin efficiencies are not available for all types of extended surfaces. For example, fin efficiencies would be very difficult to estimate for a spined tube surface such as used by Hobson and Weber[3] due to the irregularities of the spines. A number of the assumptions made by Gardner[2] in his development of fin efficiencies can not be made when dealing with the spined surface.

However, to more than compensate for the disadvantages mentioned above is the fact that the total area for heat transfer has been increased by a considerable amount. Thus, the use of extended surface equipment is advantageous from the point of view of heat transfer performance.

Pressure drop characteristics, however, would favor the use of plain surfaces. The greater area of the extended surface equipment, naturally, produces a greater rate of change of momentum in the flowing fluid. Also, some types of fins impede flow to a considerable extent.

Hence, in the selection of extended surface equipment, the benefit obtaind by the increased rate of heat transfer must be balanced against the increased pressure drop through the equipment which increases pumping costs. Finally, the benefit must be of such proportions that the increased cost of the equipment can be justified.

In this study of comparative performance, three different types of extended surfaces—continuous longitudinal fins, transverse helical fins, and spines—and one plain surface are considered. The literature references for the data used and the physical dimensions of the concentric pipe exchangers are given in Table 1. The physical dimensions, while not exactly similar, are approximately so and certainly the degree of similarity is great enough to allow valid comparisons.

All the heat transfer and pressure drop calculations were made on the basis of an exchanger one foot long. Air was selected as the annular fluid. The relatively low air film coefficient

TABLE 1
Physical Dimensions of the Concentric Pipe Exchangers

Type of Exchanger	Reference	Inside Diam. of Outer Pipe, D_{io}, In.	Diam. Base Tube, Inch	Equivalent Diam., D_e, Ft.	Surface Area Ft²/Ft.	Area of Free Flow, Ft²
Plain Tube	(4)	2.24	0.623	0.1347	0.164	0.0252
Transverse Helical Finned Tube	(4)	2.24	0.623	0.1233	0.442	0.0247
Continuous Longitudinal Finned Tube	(1)	3.068	1.90	0.0346	2.525	0.0285
Spined Tube	(3)	2.469	0.626	0.1407	1.11	0.02607

Compare Finned and Plain Tubes . . .

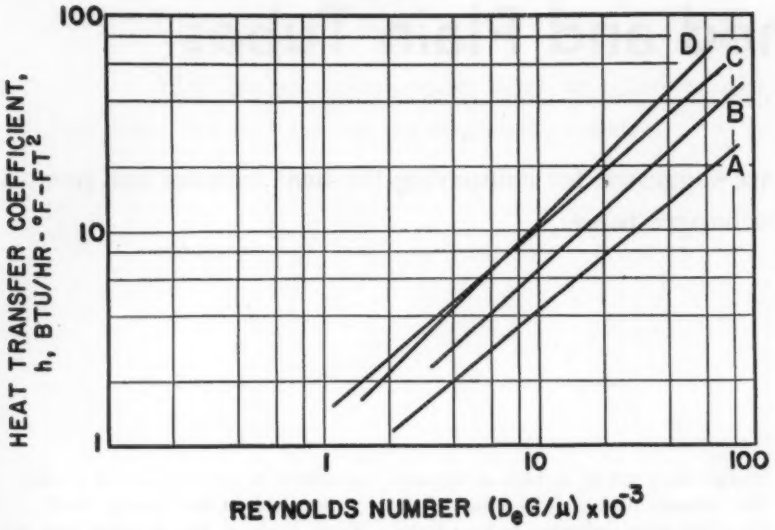
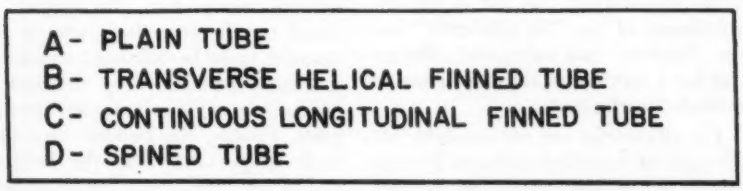


FIGURE 1—A comparison of heat transfer coefficients on the basis of Reynolds Numbers may be misleading.



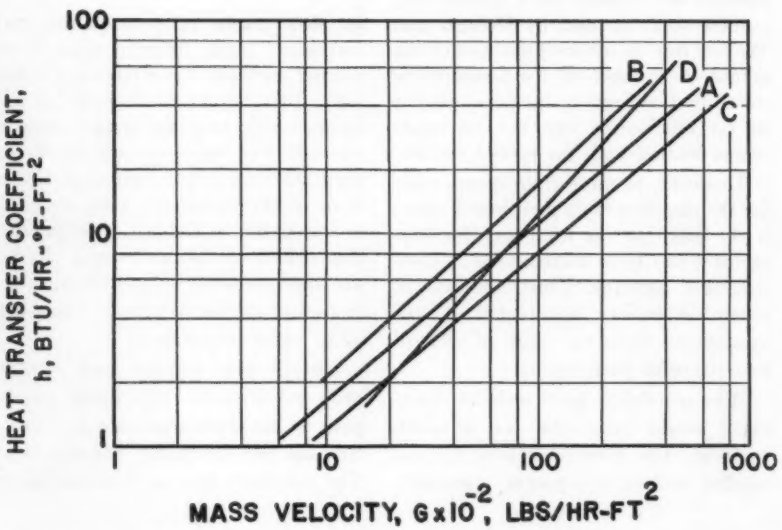


FIGURE 2—A comparison on the basis of mass velocity eliminates the equivalent diameter term.

tends to minimize the effect of fin efficiency. The resistance to heat transfer offered by the air film is comparatively large so that the resistance offered by the pipe wall becomes unimportant. An average air temperature of 100° F. and an average pressure of 15 psia were used in the calculations.

From the data available in the references cited in Table 1, the conditions outlined in the preceding paragraph, and the assumption of various air flow rates, it was possible to calculate mass velocities, Reynolds numbers, heat transfer coefficients, pressure drops, and other desired quantities for all of the concentric pipe heat exchangers.

A comparison of the heat transfer coefficients for the surfaces as a function of the Reynolds number initially was felt to be one valid comparison of the heat transfer characteristics of the exchangers. Such a plot is Figure 1. However, the comparison is invalid because the equivalent diameter cannot be determined rigorously for the exchangers which included the spined tube and the transverse helical fin. For instance, Hobson and Weber[3] arbitrarily defined the equivalent diameter for the spined tube exchanger as:

$$D_e = D_{io} - D_t$$

where D_e = equivalent diameter, ft
D_{io} = inside diameter of outer pipe, ft
D_t = diameter of base tube, ft

and Knudsen and Katz[4] defined the equivalent diameter of the transverse helical fin exchanger as:

$$D_e = D_{io} - D_f$$

where D_f = diameter of fin, ft

A more valid comparison might consider the heat transfer coefficient as a function of the mass velocity, since this eliminates the equivalent diameter term from the independent parameter. This type of plot is Figure 2. It will be noted that the relative positions of the lines representing the various exchangers are altered quite markedly. If this procedure is carried a step farther, i.e. the heat transfer coefficient is plotted against the weight rate of flow, w, the necessity of calculating a cross-sectional area of flow is eliminated. The sectional area is a difficult term to evaluate in the exchangers employing the spined tube and the transverse helical fin. A plot of the heat transfer coefficient as a function of the weight rate of flow was made as a part of this investigation but is not included because the results were essentially the same as those presented in Figure 2.

Considering only the results presented in Figure 2, one would question the use of the continuous longitudinal fin type of extended surface and would be led to favor the use of the transverse helical fin surface over other types of extended surfaces

and the plain tube. However, Figure 2 does not give all the facts concerning the heat transfer performance.

The product of the heat transfer coefficient and the heat transfer area of the various exchangers as a function of the mass velocity is a better comparison than that illustrated in Figure 2. The effects of the heat transfer coefficient and the increased area due to the extended surfaces are taken into account then. A plot of this nature is Figure 3.

One would conclude from Figure 3 that all the extended surface exchangers considered transfer more heat per unit temperature differential than a concentric pipe exchanger which uses a plain tube as the inner element. Also, that the continuous longitudinal fin surface is the best of the extended surface types. The reason for the large change in the relative positions, be-

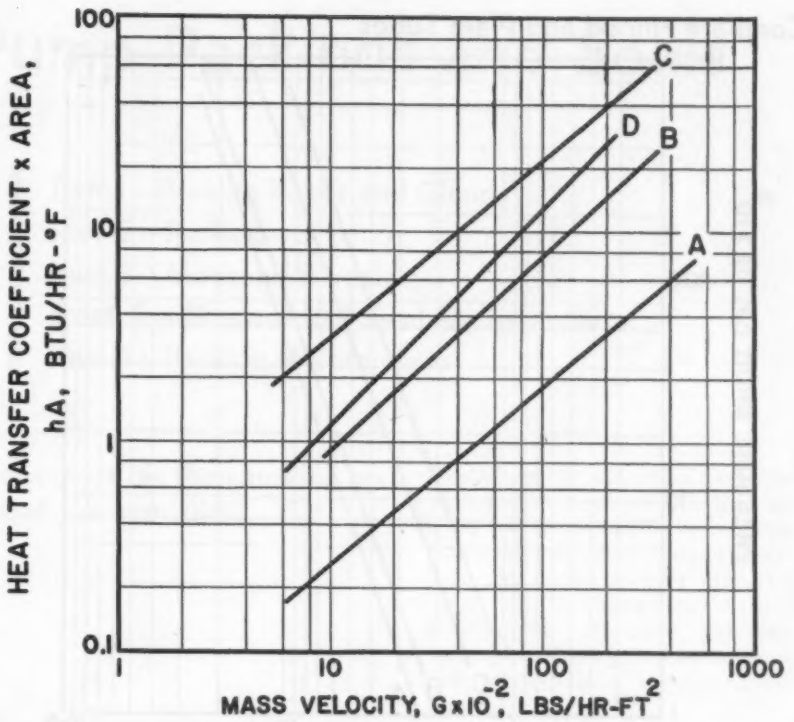


FIGURE 3—The product of the heat transfer coefficient and the surface area gives a better indication of the effectiveness of a tube.

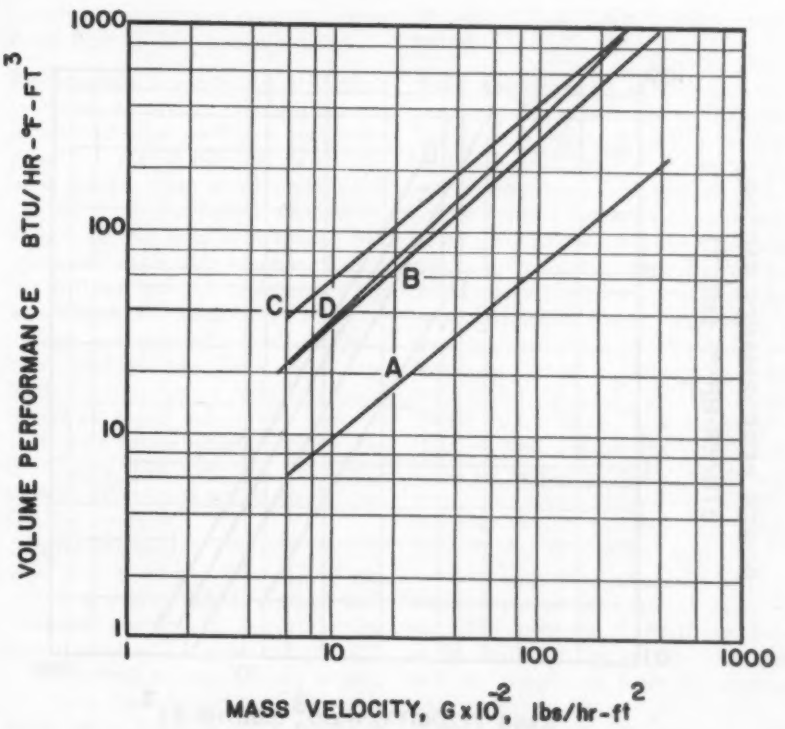


FIGURE 4—A comparison of the tubes on a volumetric basis agrees with the comparison shown in Figure 3.

About the Authors

Hobson

Weber

MERK HOBSON has been teaching and doing research as an Associate Professor at the University of Nebraska since 1950. Prior to this he spent three years as a process engineer for Esso Standard Oil Company in Baton Rouge, La., three years as product design and development officer with the U. S. Army, and one year as a lecturer at Northwestern University. Dr. Hobson received his B.S. degree from Wisconsin University, and his M.S. and Ph.D. from Northwestern.

JAMES H. WEBER is an associate professor of chemical engineering at the University of Nebraska. In addition to his teaching duties, Dr. Weber carries on research in chemical engineering. A 1941 graduate of the University of Pittsburgh, he completed his M.S. there in 1947, and his Ph.D. the following year. He is a member of American Chemical Society of Engineering Education, and an associate member of American Institute of Chemical Engineers.

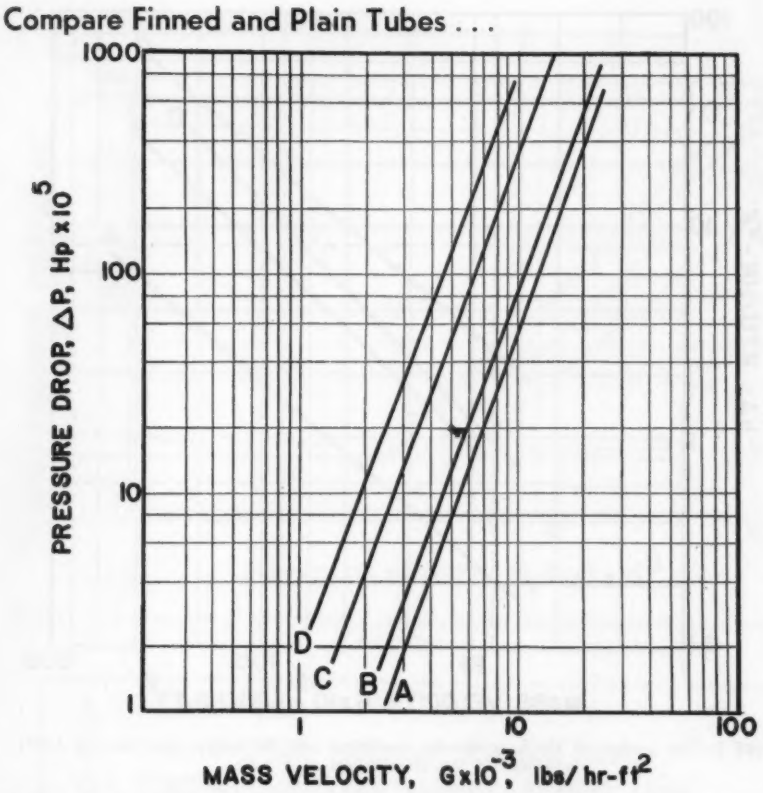


FIGURE 5—The selection of heat exchanger tubes must take into account pressure drop and equipment cost.

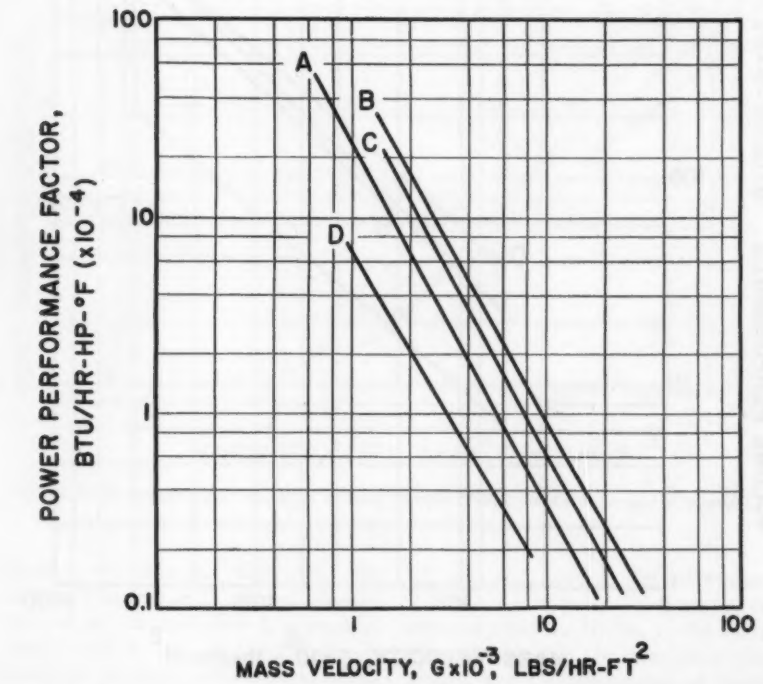


FIGURE 6—The power performance factor combines the characteristics of heat transfer and pressure drop.

tween Figures 2 and 3, of the lines representing the various exchangers may be attributed to surface areas. Refer to Table 1. The continuous longitudinal finned tube has, comparatively speaking, a large heat transfer area, while the transverse helical finned tube has a comparatively small heat transfer area, and, of course, the plain tube has the smallest area.

The final comparison of the heat transfer characteristics of the various exchangers is shown in Figure 4. In this plot the volume performance, hA/V, is plotted against the mass velocity. The use of the volume performance eliminates, somewhat, the differences in the physical dimensions of the various exchangers considered. The results of the correlation further substantiate the results presented in Figure 3.

The pressure drop characteristics were studied by plotting this variable versus mass velocity. This plot in Figure 5 shows that the plain tube exchanger produces a lower pressure drop at a given mass velocity than any of exchangers which use extended surface tubes. Based on this criterion, the spined tube exchanger is the least desirable, as might be expected.

To combine heat transfer and pressure drop characteristics, power performance factors, hA/ΔP, were calculated. These data, plotted against mass velocities, are presented in Figure 6. Using the power performance factor as the criterion, one would select transverse helical finned or continuous longitudinal finned equipment in preference to the plain tube exchanger. But, the plain tube exchanger is preferable to the exchanger with the spined tube as the inner element. Nevertheless, the cost of the various types of equipment must be considered before final selection is made.

NOTATION

A = total area of heat transfer per foot of exchanger, ft^2/ft
ΔP = pressure drop per foot of exchanger, Hp/ft.
V = total volume per foot of exchanger based on the inside diameter of the outer pipe, ft^3/ft.
h = heat transfer coefficient based on the outside area of the inner element of the exchanger, $Btu/hr\text{-}ft^2\text{-}F$.

LITERATURE CITED

[1] De Lorenzo, B., and Anderson, E. D., *Trans. Am. Soc. Mech. Engrs.*, 67, 697 (1945).
[2] Gardner, K. A., ibid., 67, 621 (1945).
[3] Hobson, M., and Weber, J. H., *Ind. Eng. Chem.*, 46, 2290 (1954).
[4] Knudsen, J. G., and Katz, D. L, *Chem. Eng. Progr.*, 46, 490 (1950).

Centrifugal Pump Packings and Seals

Handbook

Part 1 – Packing Boxes and Glands
Part 2 – Packings
Part 3 – Mechanical Seals
Part 4 – Mechanical Seal Maintenance
Part 5 – Packing Maintenance

Here's a complete report on the cause of seal troubles, what to look for, and the remedies.

Harold Woodhouse
Dean Hill Pump Company
Indianapolis

THERE ARE many difficult mechanical seal applications operating where regular packing would either be entirely impracticable or have a very short life. The use of a mechanical seal does not guarantee indefinite, trouble-free operation. Sometimes only continuous experimentation with seal materials and construction will add to seal life in a particular difficult application.

The installation instruction manuals of mechanical seal manufacturers usually start with a caution or reminder that the seal is a precision product and should be handled accordingly. Most of the residual opposition to the use of mechanical seals can be traced to failures in operation caused by faulty handling and installation.

The first warning regarding seal handling is that one must be especially careful not to scratch the rotating and stationary seal faces. As shipped, the seal faces are protected from contact with each other or anything else by a piece of soft material, usually cardboard. This should be left in place until actual installation, except to inspect the seal surfaces for nicks, scratches and foreign matter.

If a mechanical seal leaks because of damage to either the rotating or stationary seal faces, these faces must be replaced or re-lapped. Do not jump to the conclusion that because the seal leaks, it is necessarily due to defective seal faces. Other causes for leaks will be discussed. Some seal faces may show well defined circumferential grooving and yet not leak. The nicks, cracks or scratches which cause trouble are those which run transversely across the face permitting flow from high to low pressure side.

Re-Lapping. The question of whether to re-lap or replace depends on the number of seals used in a particular plant. If considerable numbers are used, the purchase of a lapping plate (Figure 1) is warranted. Ordinarily, a finishing lap only is sufficient, but where a considerable number of seals are to be refinished, a roughing lap would speed the work.

Laps are generally made of soft, close grained cast iron. They are made thick to have a rigidity of form but often cored out at the back, as shown, to reduce weight without loss of rigidity. The face has a diagonal pattern of grooves which collect the lapping residue.

After thoroughly cleaning the lap face with a solvent (not with a rag or brush) the surface is charged with diamond powder, in a paste form, and applied with a roller.

If the seal faces are badly scored, the faces can be remachined on a lathe prior to lapping, if *skillfully* done. With bronze faces this is not too difficult; hard materials like stellite call for special cutting tools. Carbon calls for a special technique and is no job to be tackled by an inexperienced machinist. With a prayer that the carbon doesn't chip, one starts from the outside diameter, using a carbide or sharp nosed, high speed tool having a 5-degree lead angle and 7-degree rake, machining inwards with a fine cut.

Bronze and carbon have porous surfaces; therefore, they can become laps themselves, after a lapping operation, because of the embedded diamond compound. Such seal parts can cause seal failure in a few hours; so they should always to washed in a suitable, clean solvent before reassembly.

Seal Leakage. A mechanical seal may leak for reasons other than defective seal faces. Figure 2 with a wedge shaped shaft seal ring at A, which may be teflon and Figure 3 which shows a bellows type shaft seal at *B*, generally of neoprene or buna, are points at which leaks may occur. It is frequently caused by maintenance personnel assembling a seal over a shaft which has burrs either along its length or at the shoulder where the ring is first pushed over the shaft. There, steel burrs cut a groove through the bore of the soft teflon, buna or neoprene ring. This groove may look like an insignificant scratch to inexperienced personnel but it can be sufficient to ruin the seal.

Shaft seal rings are made with a bore to a close tolerance so as to be a *push-fit* over the shaft. If the shaft is not held to the proper tolerance and the ring is a loose fit, leakage will result.

Arrow *C* (Figure 2) points to one of several set-screws which are used to lock the rotating element, of this

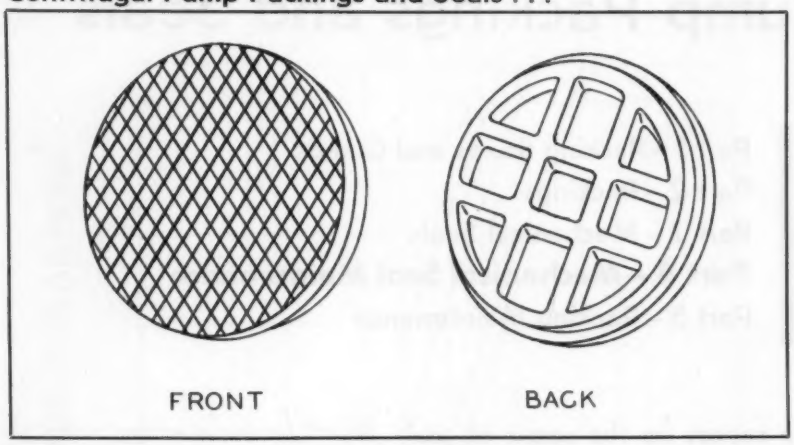


FIGURE 1—Lapping plates have grooved faces to collect residue.

type of mechanical seal, on the shaft. The set screws are supposed to lock the rotating element axially so as to maintain dimension 'd' specified by the manufacturer, for that particular size and design of seal. If assembled with dimension 'd' too large, the helical coiled springs, shown, may not be able to maintain the rotating seal face in contact with the stationary seal face (there is a stop pin which limits the axial travel of the rotating seal) and there will be a leak past the gap left between the two seal faces. Sometimes, the set screws come loose and allow the rotating seal to move away from the stationary seal and a similar leakage results.

If a seal is in service a long time, and seals with 8 or 10 years continuous service are not uncommon, one or both of the seal surfaces may wear so much that the maximum permissible axial travel of the rotating seal is used up and contact of the seal surfaces can no longer be maintained.

Another source of leakage, not caused by wear, is the result of crystallization and deposits on all parts of the seal. What then happens is as follows: Because of pump shaft flexibility and a certain amount of run-out of parts, there is a very slight axial movement of the rotating seal face. It is maintained, normally, in contact with the stationary seal face, because it is flexibly mounted and has spring pressure behind it. The pump might be stopped at the shaft position where the rotating element springs are most compressed (i.e. Dimension 'd', Figure 2, for the rotating seal, is a minimum). Then, if deposits or crystallization continue to build up, the rotating elements becomes frozen together as a solid mass and the springs become inoperative and will not be able to move the rotating seal to maintain complete contact when the pump is again started. This condition can build up even if the pump runs continuously.

Sometimes such a condition can be corrected by removing and mechanically cleaning each part or by washing in a suitable solvent. However, if a condition of possible crystallization or deposits are known prior to ordering the pump, double seals, or a single seal arranged for flushing, should be specified (See Part 3, "Mechanical Seals").

Before discarding a mechanical seal because of wear, one should not overlook the fact that some designs are made with a reversible stationary seat (see Arrow *E*, Figure 2). By reversing this seat and re-lapping the rotating seal, the assembly is as good as new.

If there is repeated failure of mechanical seals in any one specific application, in spite of excellent maintenance procedures, a reappraisal with the seal manufacturer of the materials used in the seal is in order. Seal manufacturers, like everyone else, are learning by experience, and the particular application might be one in which their experience is limited.

INSTALLATION TIPS

Specific installation instructions are furnished with, and vary for, each design of mechanical seal. Only general instructions which apply regardless of design variations can be given here:

1. If the pump has previously been

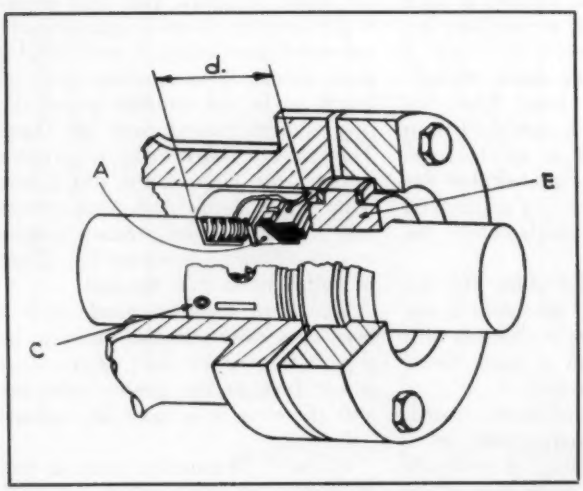


FIGURE 2—Setscrews lock the rotating seal element so that the coil spring can maintain contact with the stationary face.

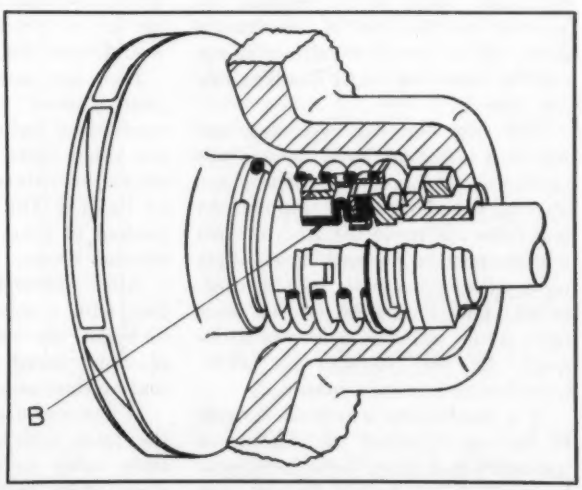


FIGURE 3—Seal leakage may be caused by a faulty, bellows type, shaft seal.

using packing, the stuffing box should be thoroughly cleaned to remove all traces of packing and, if used, the lantern ring. It may be necessary to plug some holes in the stuffing box wall which will not be required with a mechanical seal. One difficulty, sometimes experienced with packing to seal conversion jobs, is that the stuffing box face must be a machined surface, square with the shaft, against which the stationary seal gland plate may be tightened. Often, with pumps designed only for packing, this surface will have been left unmachined. It is then necessary to set the pump up for this machining operation.

2. Hone all sharp edges of the shaft over which the shaft seal ring must pass.

3. Hone edges of keyways over which the shaft seal ring must pass and fill with wooden, flush keys.

4. Oil shaft with a light oil, not grease, before assembling the shaft seal ring.

5. If any difficulty is experienced in assembling the inner seal ring over the shaft, after taking precautions 2, 3 and 4, check the shaft diameter. It must be within the specified tolerance which, generally, will be only a few thousandths of an inch.

6. Thoroughly clean and oil both seal faces.

7. If the rotating assembly is set for axial location by set screws, check distance 'd', Figure 2, for the correct dimension. If the axial length setting of the seal assembly is determined by the distance between two shoulders or sleeve face or impeller hub face or gland plate face, check this distance.

8. Check all springs and parts for proper seating and the rotating seal face for a slight freedom of movement in all directions, to ensure seating.

9. The shaft must have no end play. This may cause the seal faces to come apart or cause a hammering effect on the faces with subsequent reduction in life.

After Installation of Seal

1. Before starting the pump, where possible, subject seal to a static pressure near the operating pressure, to check for leakage.

2. Where an independent seal lubricating system is provided, see that it is operating before starting the pump. Its pressure should be 10 to 15 pounds per square inch gage greater than the pressure of the pumped liquid, at the point adjacent to the seal.

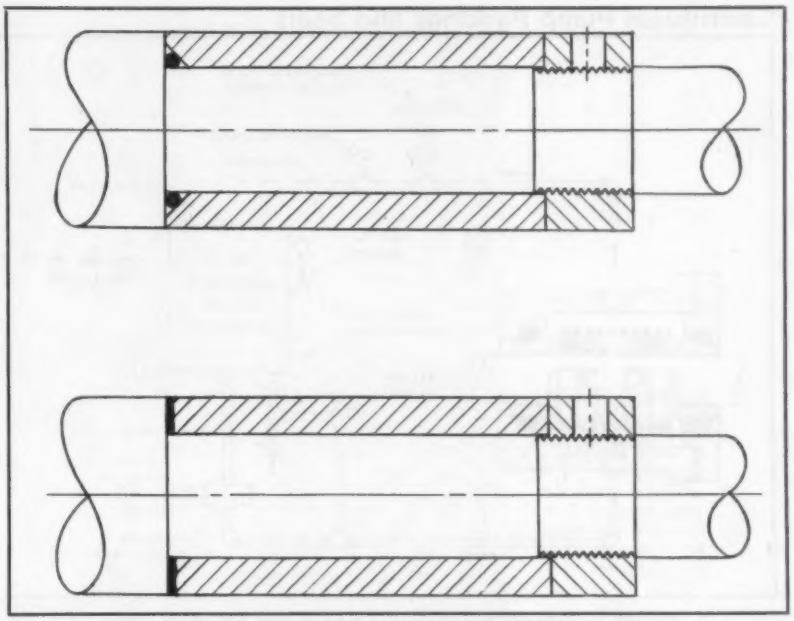


FIGURE 4—For mechanical seals on sleeves rather than a shaft, a gasket or "O" ring prevents leaks at the shoulder.

3. If, a slight leakage is noted after proceeding with step 1, try adjusting slightly, the stationary gland, plate nuts. Particularly with packing to seal conversion jobs, where only two gland bolts are available to tighten the stationary gland plate, the gasket between it and the casing may be improperly tightened allowing a fluid leakage. This can easily be confused with seal face leakage.

Pumps specifically designed for mechanical seals should have three or four gland plate bolts rather than two. If adjusting the gland bolts has no effect on the leakage or reduces it only to a certain minimum without completely eliminating it, do not be too disturbed. If the leakage is not caused by a leaky gland plate gasket, it may cease as the seal faces seat themselves while running. This can take only a few minutes or a few hours.

Maintenance of Seal

1. If seal leakage is observed, do not jump to the conclusion that the seal faces are the cause. It might be a leaky gland plate gasket or shaft seal ring or leakage under a shaft sleeve.

2. If the seal should leak through the gland plate gasket, see if the gland nuts can be tightened. Tighten them carefully and evenly. Do not tighten them so that the gland plate is sprung, as this will cause leakage between the seal faces. If the leak continues, check the stuffing box face for irregularities.

The next step is to install a new gasket. At that time, however, check the condition of the gasket removed, carefully, since it is possible that an unsuitable material, subject to erosive or corrosive action of the pumped liquid, is being used.

3. To check shaft seal ring leakage, it should be removed and its bore inspected. In the act of removing it, note if its fit on the shaft is what is described as a *push-fit*. A running type of fit would definitely allow leakage along the shaft.

If the bore of the seal ring shows any transverse scratch, it probably was cut at the time the ring was assembled, by a burr on the shaft. If the shaft burr or burrs are not removed, then they will similarly damage any new shaft seal ring installed. The shaft or shaft sleeve on which the shaft seal ring fits should be lubricated with a light oil to facilitate assembly.

4. Where a mechanical seal fits on a sleeve rather than directly on a shaft there is always the possibility that leakage may seep between the sleeve bore and the shaft. To avoid this leakage the sleeve face must be butted up tightly against a shaft shoulder with a gasket or 'O' ring in between, as shown on Figure 4. The condition of this gasket or 'O' ring should be checked.

5. If the seal rotary and stationary faces are cracked, scratched or badly

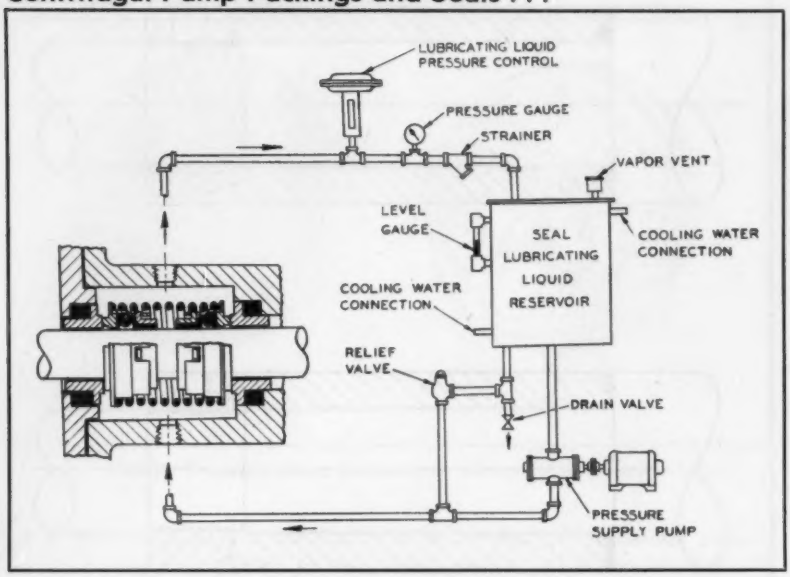


FIGURE 5—Elaborate arrangement of external seal lubricating system.

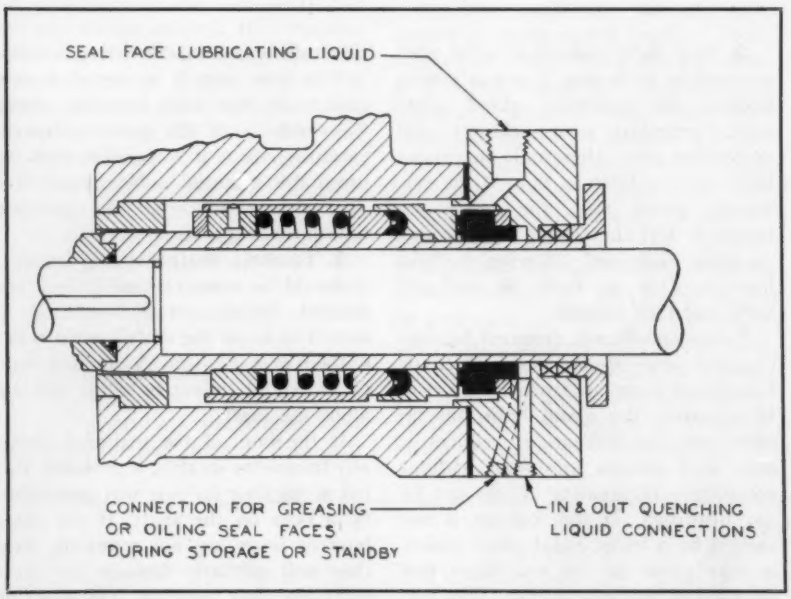

SEAL FACE LUBRICATING LIQUID
CONNECTION FOR GREASING OR OILING SEAL FACES DURING STORAGE OR STANDBY
IN & OUT QUENCHING LIQUID CONNECTIONS

FIGURE 6—Some seals can be lubricated externally for shipping, storage or idle standby protection.

worn, they are probably the source of leakage and should be replaced. Do not, however, replace these parts, or the complete seal, without giving some thought to the cause of failure, particularly if the seal life has been short. Check for shaft end-play which allows seal faces to come apart or hammer together.

Check that spring retainer is located axially on the shaft to give the correct compression on the seal spring or springs. The locating setscrews may have been improperly placed to begin with or they may have backed off in operation. Where axial location is dependent on sleeve or shaft shoulder or distance piece, check for proper setting.

6. If seal faces fail, check to determine that they have been properly lubricated.

Like all rubbing surfaces, the rotary and stationary seal faces will generate a frictional heat which may result in their reaching a high temperature with galling of their mating surfaces and seal failure, if they are not lubricated.

Lack of lubrication is, therefore, one of the points to be considered in evaluating some cases of seal failure. Do not conclude that because a lubrication line to the stuffing box is not clogged or that there is clearance past a close running sleeve, allowing some flow into the stuffing box, that the seal has been adequately lubricated.

In some instances the pressure of the lubricating liquid piped to the stuffing box, in the space around the seal, has been lower than the vapor pressure corresponding to its temperature. The result has been that the lubricating liquid has flashed into vapor and failed to provide sufficient lubrication. The obvious solutions are either to increase the lubricating liquid pressure or reduce its temperature.

Where the lubricating liquid is the pumped liquid and the amount of flow to the stuffing box is limited by the restricted clearance past a rotating sleeve or collar (see Figures 1 and 11, Part 3, this series), the flow may be insufficient to keep the liquid below the vapor flashing point because of the input to it of frictional heat from the rubbing seal faces. It may be sufficient to increase the clearance, thereby permitting more flow into the stuffing box. But, in some instances, it may be necessary to provide better circulation to carry away the heat by adding an outlet connection to the stuffing box where the lubricant may be withdrawn.

In many instances where the pumped liquid is unsuitable for use as a seal lubricant it is necessary to provide the rather elaborate arrangement shown by Figure 5 for seal lubrication.

7. Where the seal lubricant is piped from the pump discharge to the seal and it is an inflammable, explosive, toxic or expensive liquid, give consideration to putting an orifice in this line. Then, in the event of complete failure of the seal there will not be an extensive, disastrous or expensive loss of liquid.

8. Some pumps, especially if purchased for standby service, may have provision for oiling or greasing the seal faces to protect them during shipment, storage or idle standby. Check that this is done. Figure 6 illustrates such a design.

Part 5 of this series will appear in a coming issue of PETROLEUM REFINER

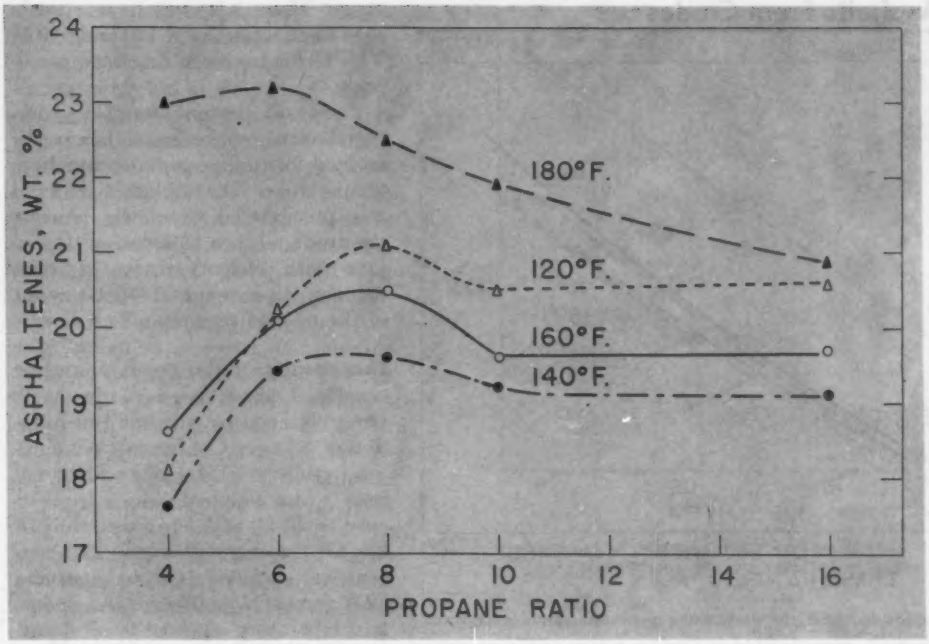


FIGURE 1—Although asphaltene yields were maximum near a propane ratio of 8 : 1, precipitations were made as high as 16 : 1 because many industrial processes operate in that range.

Propane Removes Asphalts From Crudes

A batch method is used to study the effects of temperature and propane-oil ratios. The results may be applied to counter-current towers.

H. N. Dunning and J. W. Moore
Petroleum Experiment Station, Bureau of Mines
Bartlesville, Okla.

PROPANE IS unusually effective for precipitating the high molecular-weight components of petroleum and, therefore, has found wide industrial application. An extensive laboratory study has been made to determine optimum conditions for removing nitrogenous, metallic and asphaltic materials from a Mid-Continent crude oil by precipitation with propane. The conditions for precipitation have been investigated throughout the temperature range from 120 to 180 F. with propane-oil ratios from 4:1 to 16:1. The efficiency of precipitation was determined by asphaltene yields and nitrogen contents of the asphaltenes and raffinates.

The lowest asphaltene yields, throughout the range of propane-oil ratios, were obtained at 140 F. For a given temperature, the highest yield was obtained at a propane-oil ratio of 8:1 except at 180 F. where the maximum yield was obtained at a propane-oil ratio of 6:1. The asphaltene yield ranged from 23.2 to 17.6 wt. percent and averaged 20.3 wt. percent. The average nitrogen contents of the crude oil, asphaltenes, and raffinates were 0.37, 1.23, and 0.17 wt. percent, respectively.

The propane deasphalting process removes much of the ash, nickel, vanadium, and nitrogen from the oil and results in marked decreases in its viscosity and carbon residue. The method is shown to be highly versatile and applicable for the improvement of petroleum stocks and fuels.

The adverse effects of metallic and nitrogenous materials in feed stocks and fuels are generally recognized. Jones and Hardy[6] showed that petroleum ashes containing vanadium were destructive to the refractories of industrial furnaces, Thompson and others[9] reported that nitrogenous materials caused copious sludge formation in furnace oils, and Mills[7,8] showed that small amounts of metallic and nitrogenous substances poisoned clays and synthetic cracking catalysts. These materials are mainly associated with the asphaltic constituents of crude oils and residua.[2-5]

Propane is unusually effective for precipitating the high molecular-weight components of petroleum and therefore has found wide industrial application in the preparation of lubricating stocks and feed stocks for catalytic cracking. Ditman and Mertens[2] showed that bench-scale batch deasphalting methods gave results

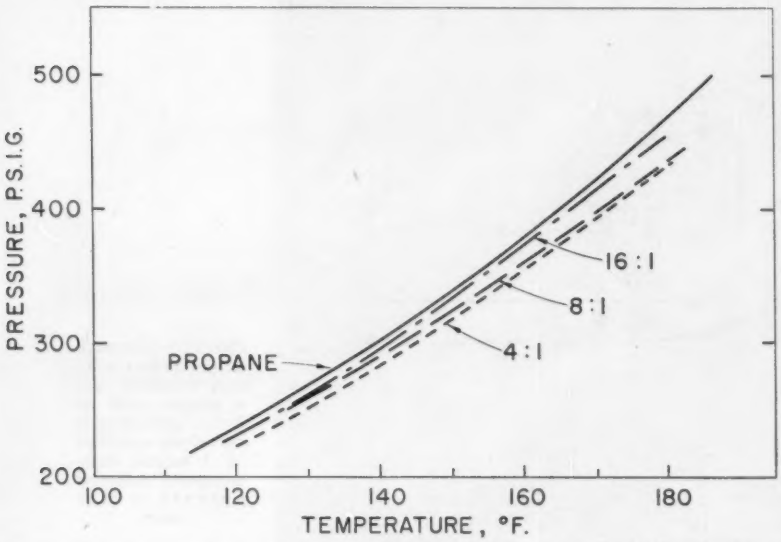


FIGURE 2—As the proportion of propane decreases, the pressure at a given temperature is decreased.

comparable to counter-current towers and concluded that the batch method was a valuable tool for studying the propane-deasphalting process.

An extensive laboratory study was made to determine optimum conditions for removing nitrogenous, metallic, and asphaltic materials from a Mid-Continent crude oil by precipitation with propane. The conditions for precipitation were investigated through the temperature range from 120 to 180 F., with propane-oil ratios from 4:1 to 16:1. The efficiency of precipitation was determined by asphaltene yields and nitrogen contents of the asphaltenes and raffinates.

The precipitation of asphaltenes from this Oklahoma crude oil was investigated under a wide variety of conditions. Propane-oil ratios ranged from 4:1 to 16:1 over a temperature range from 120 to 180 F. The effects of these variables on asphaltene precipitation are shown in Figure 1.

The greatest sensitivity to propane-oil ratio is observed at 120 F., the lowest temperature, and the least at 180 F., the highest temperature used. Although there appeared to be maxima in asphaltene yields at a propane ratio of 8:1, precipitations were made at a ratio of 16:1 because many industrial processes operate in that range. There is a definite reversal in solvent effect between 120 and 140 F. This effect has been described previously.[1]

Propane precipitation was compared to the more common laboratory method of using pentane at room temperature. The asphaltic material was precipitated by slowly pouring the crude oil into 13 volumes of pentane with violent stirring. In this manner, an average of 14.5 percent of the oil was precipitated.

The results of the bomb procedure developed above were compared to those obtained by propane precipitation of a heavy California (Wilmington) crude oil. The oil, which had been steam stripped, was deasphaltened at 70 C. and a propane ratio of 8:1. Of the original charge, 23.5 percent was obtained as asphaltenes and 72.8 percent as raffinate. An industrial laboratory reported that 8.7 percent of the oil was precipitated by pentane dilution and, after removal of the pentane, an additional 14.5 percent of the oil was precipitated by propane at a ratio of 20:1. The total amount of asphaltic material obtained was therefore 23.2 percent.

Temperature-pressure relationships at propane ratios of 4:1, 8:1, and 16:1 and with the sample of the propane were investigated. The results are summarized in Figure 2.

Individual experimental points are omitted from Figure 2. The curve for propane agrees closely with literature data.[10] As the proportion of crude oil increases, the pressure at a given temperature is decreased. Pressures at the various propane ratios and temperatures may be determined from these curves.

Figure 1 indicates the diversity of the method. The fact that equivalent yields at different temperatures may be obtained by properly selecting the propane ratio should allow selection of conditions for the best fractionation of the complex components of asphalt. Perhaps of more practical importance, the efficiency of deasphalting that might be accomplished in a counter-current tower at various temperatures and propane-oil ratios is evident.

The nitrogen contents of the several fractions were used to determine the fractionation accomplished in the precipitations. The weight percentage of nitrogen in the asphaltene frac-

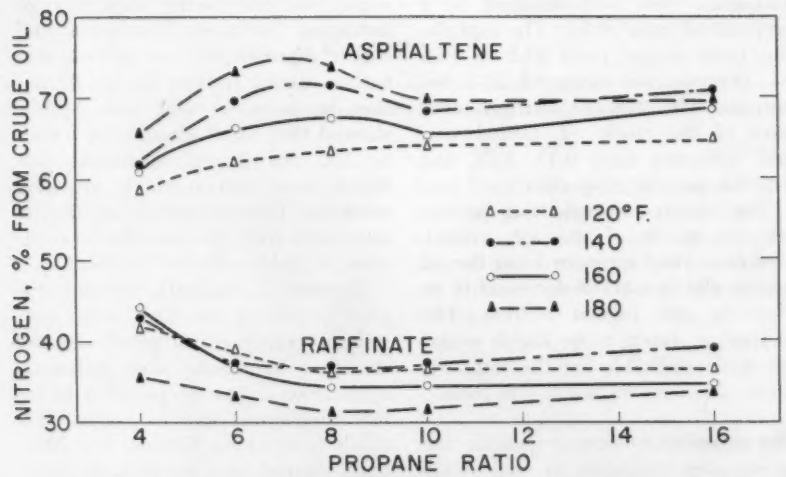


FIGURE 3—The total amount of nitrogen precipitated is the greatest at 180 F.

tions ranged from 1.11 to 1.38; the average nitrogen content of the fractions reached a maximum at 140 F. and a minimum at propane ratios of 6:1 and 8:1. These conditions correspond to the minimum and maximum asphaltene yields, respectively, shown in Figure 1, indicating that the amount of nitrogen precipitated is relatively constant while the amounts of other substances precipitated vary considerably. This relationship is observed in Figure 3, which shows the distribution of nitrogenous materials among the raffinate and asphaltene fractions. The total amount of nitrogen precipitated is greatest at 180 F. If the results at the several temperatures are averaged for each propane ratio, the relative constancy of total nitrogen precipitated is even more evident. This correlation is interpreted as indicating that most of the nitrogenous components precipitated are among the most polar of the asphaltic constituents and therefore are among the first to precipitate. Apparently, this constancy of nitrogenous substances precipitated also indicates that there is less range in the properties of the nitrogenous constituents than in the asphaltenes in general.

The asphaltenes precipitated with this range of conditions were hard and often brittle. For this reason it was necessary to determine penetration values using 200 grams on the needle at 115 F. It was observed that

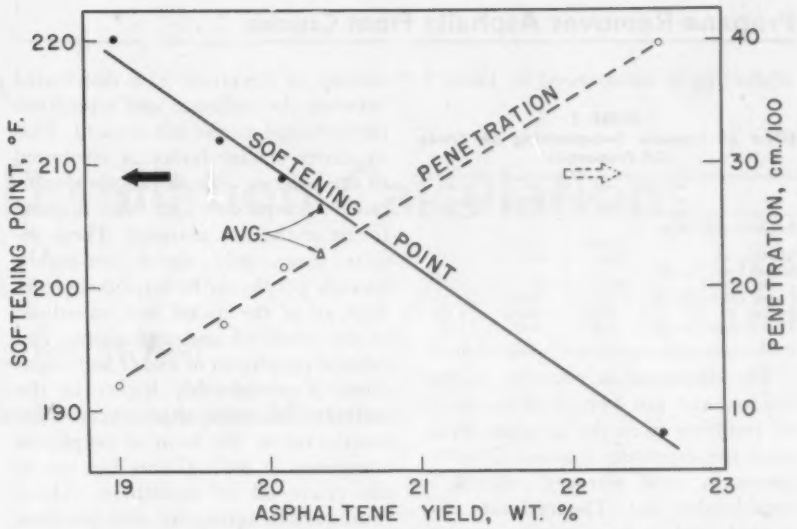


FIGURE 4—Properties of softening point and penetration are most readily correlated when propane-oil ratios are averaged at a given temperature.

softening points decreased and penetrations increased with increasing asphaltene yields. These properties are most readily correlated when the values for various propane-oil ratios at a given temperature are averaged. The results are shown in Figure 4.

The softening points of individual samples ranged from 170 to 240 F. while the penetrations ranged from 6 to 68 hundredths of a centimeter. The lowest softening point and highest penetration corresponds to the highest asphaltene yield, obtained at 180 F. and a propane-oil ratio of 6:1. However the highest softening point and lowest penetration were observed with a sample of moderate yield obtained at 140 F. and 16:1. Correlations of these results indicate the precipitation of resinous materials as well as asphaltic materials at the highest temperature (180 F.) used. The peculiar effects of temperature changes on the deasphalting process have been discussed extensively by Bray and Bahlke.[1]

The general improvement of the crude stock as a result of propane de-

Here Are Details on the Laboratory Method Used

THE CRUDE-OIL sample was obtained from Tatums field, Carter County, Oklahoma. It was produced from the Deese sand (Pennsylvanian age) at a depth of 2250 feet and is relatively high in asphaltic content (7.3 percent carbon residue) compared to other Oklahoma oils. The properties of this oil are summarized in Table 1.

The propane used was technical grade from Phillips Petroleum Company, and contained a minimum 95 mole-percent of propane. The other solvents used were analytical reagent grade.

The precipitation chamber was an American Instrument Co. pressure reactor (bomb), equipped with a rocking and heating mechanism. The bomb had a capacity of two liters and was used with only minor modifications in the valves and piping. The bomb was sealed, tested for leaks by pressuring with nitrogen, evacuated, and a weighed crude-oil sample introduced. Then propane was introduced into the bomb on a weight basis from a stainless steel bottle. The bomb was rocked during heating and at the desired temperature until equilibrium was attained, usually about an hour. The asphaltenes formed a semisolid mass on the bottom and the walls of the bomb, allowing the propane solution to be forced off by inverting the bomb. The propane solution was collected in dry-ice traps. Finally, the asphalt was washed twice with propane at the same temperature and pressure used during the precipitation. Both washes were combined with the original propane solution and the propane allowed to boil off slowly to obtain the raffinate. Most of the asphalts were removed manually after the bomb was opened and the small amounts remaining were recovered for yield data by washing the bomb and fittings in benzene.

Ring-and-ball softening points of the asphaltene samples were determined in accordance with ASTM method E28-51T. Penetrations were determined in accordance with ASTM method D5-52 and a modification of the method to allow its use for samples too small to comply with the specified procedure. As a check on the accuracy of the modified method, penetrations of several small samples precipitated at 160 F. were determined. Then these samples were combined and ASTM penetrations measured. The results agreed well within the limits of error of the method so it was concluded that the values determined with small samples were acceptable. Penetrations, in hundredths of a centimeter, were measured using 200 grams on the needle for five seconds at 115 F.

Nitrogen contents of the fractions were determined by the macro Kjeldahl method. Metallic contents of raffinate, asphaltene, and crude oil samples were determined with wet ashing procedures and an emission spectrograph.[4]

asphalting is summarized in Table 1.

TABLE 1
Effect of Propane Deasphalting on Crude Oil Properties

	Crude Oil	Raffinate	Asphaltene
Specific Gravity (60/60 F)	0.896	0.875	.....
API Gravity	26.4	30.3	.....
Saybolt Univ. Viscosity (sec. at 100 F.)	165	64	.....
Carbon Residue (wt.%)	7.3	0.86	.....
Ash (wt. %)	0.028	0.002	0.160
Total Nitrogen (wt. %)	0.37	0.17	1.23

The decreases in viscosity, carbon residue, and ash content of the crude oil resulting from the propane treatment are especially marked. The decrease in total nitrogen content is considerably less. The raffinate was treated with propane only once in these operations. Therefore, the great improvement in crude oil and feed stock properties that might be expected from counter-current processes is evident.

The precipitation of asphaltenes from the crude oil was accompanied by a separation of several metallic constituents. Metals determined semi-quantitatively that were of the order of ten times as concentrated in the asphaltene as in the crude oil were: aluminum, iron, titanium, manganese, cobalt, chromium, copper, molybdenum, lead, magnesium, and barium. No sodium was detected in the raffinate although the crude oil contained a considerable amount.

Quantitative spectrographic analyses were made to determine the vanadium and nickel contents of the crude oil fractions. The amounts of porphyrins (complex nitrogenous compounds derived from chlorophyll or hemoglobin) also were determined[4] since these form stable complexes with several metals. The results are summarized in Table 2.

TABLE 2
Metal and Porphyrin Contents of Crude Oil Fractions

	WEIGHT PERCENT		
	Crude Oil	Raffinate	Asphaltene
Nickel	0.0055	0.0003	0.0245
Vanadium	.0110	.0004	.0450
Porphyrins	.0200	.0025	.1000

The high concentration of vanadium and nickel in the crude oil and asphaltene sample is especially interesting because porphyrin complexes of these elements are unusually stable and have been identified in various fractions of this oil.[3] The porphyrin content of the crude oil is distributed between the raffinate and asphaltene proportional to the ash content. This similarity of distribution is attributed to the polarity of both the porphyrin-metal complexes and the original forms of the ash material. These results show only about one-eighth enough porphyrin to form complexes with all of the nickel and vanadium in the crude oil and asphaltene. The ratio of porphyrin to nickel and vanadium is considerably higher in the raffinate indicating that most of these metals are in the form of porphyrin complexes in the raffinate but not in the crude oil or asphaltene. These results are in agreement with previous work in this laboratory[3,4] and elsewhere.[5] The porphyrin-metal complexes are exceedingly stable and have a limited solubility in many oily materials. Therefore, the complete removal of nitrogen and these metals from many petroleum stocks probably cannot be attained by a typical solvent-extraction method. However, a marked decrease in these substances is accomplished as shown in Table 2 and reported by other workers.[2] Therefore the deleterious effects these metallic and nitrogenous substances have on processing and utilization may be minimized by propane deasphalting processes.

LITERATURE CITED

[1] Bray, U. B., and Bahlke, W. H., "Refining with Liquid Propane," *Science of Petroleum*, III, 1966 (1938).
[2] Ditman, J. G., and Mertens, F. T., "Propane Deasphalting of Residua," *Petroleum Processing*, 7, 1628 (1952).
[3] Dunning, H. N., and Rabon, N. A., "Porphyrin-Metal Complexes in Petroleum Stocks," *Ind. Eng. Chem.*, 48, 951 (1956).
[4] Dunning, H. N., Moore, J. W., and Myers, A. T., "Properties of Porphyrins in Petroleum," *Ind. Eng. Chem.*, 46, 2000 (1954).
[5] Garner, F. H., Green, S. J., Harper, F. D., and Pegg, R. E., "The Metallic Elements in Residual Fuel Oils," *J. Inst. Petroleum*, 39, 278 (1953).
[6] Jones, M. C. K., and Hardy, R. L., "Petroleum Ash Components and Their Effect on Refractories," *Ind. Eng. Chem.*, 44, 2615 (1952).
[7] Mills, G. A., "Aging of Cracking Catalyst," *Ind. Eng. Chem.*, 42, 182 (1950).
[8] Mills, G. A., and Shabaker, H. A., "Factors Controlling Aging of Cracking Catalysts," *Petroleum Refiner*, 30, 97 (Sept. 1951).
[9] Thompson, R. B., Chenicek, J. A., Druge, L. W., and Symon, T., "Stability of Fuel Oils in Storage," *Ind. Eng. Chem.*, 43, 935 (1951).
[10] Sage, B. H., Schaafsma, J. G., and Lacey, W. N., "Phase Equilibria in Hydrocarbon Systems. V. Pressure-Volume-Temperature Relations and Thermal Properties of Propane, *Ind. Eng. Chem.*, 26, 1218 (1934).

About the Authors

Dunning

Moore

H. N. DUNNING is head of the Surface Chemistry section of the U. S. Department of Interior, Bureau of Mines, Bartlesville, Okla. His duties involve supervision of research on the application of surface chemistry to petroleum production and refining, and research in natural-gas production. Prior to joining the Bureau of Mines in 1951 as a physical chemist, Dunning was a research chemist for Standard Oil Co. (Indiana). He received his B. S. degree from Nebraska State College, then went to the University of Nebraska for his M.S. degree in physical chemistry and his Ph.D. degree in physical chemistry and physics.

J. W. MOORE is an organic chemist for the Department of Interior, Bureau of Mines, Bartlesville, Okla., where his work involved identification and characterization of surface-active constituents of petroleum. Prior to joining the Bureau of Mines in 1947, Dunning was a chemist with Cities Service Oil Co. He received his B.S. degree from Oklahoma Central State College and his M.S. degree from the University of Oklahoma. He is the author of several papers on petroleum and oil shale.

Steam Batch Distillation Calculations

A NEW Method

For Multicomponent Mixtures

C. D. Holland and N. E. Welch
Texas A. & M. College
College Station, Texas

BY USE OF steam distillation a mixture of volatile components may be partially separated from its non-volatile components at temperatures such that the volatile components do not decompose and also at convenient operating pressures. In the general case, the non-volatile components are considered miscible with the volatile components. The theory is based on the requirement that the partial pressure of the steam in the vapor stream rising from the still is less than the saturated pressure of steam at the temperature of the still. This assures the absence of liquid water. The batch process is carried out at the conditions of constant still temperature and constant total pressure. The total pressure is maintained constant by increasing the rate of flow of steam to compensate for the decrease of the concentration of the lower boiling components.

For the general case the non-volatile components are considered miscible with the volatile components. This general case is derived, in the appendix, to be:

$$\sum_{i \neq s,\, r} \frac{L_i^\circ}{\beta_i}\left[1-\left(\frac{L_b}{L_b^\circ}\right)^{\beta_i}\right]+L_r^\circ \ln\frac{L_b^\circ}{L_b}=\frac{E_b P_b}{\pi}\,[L^\circ-L+S] \tag{19}$$

For the special case where the non-volatile components do not alter the mole fractions of the volatile components in the still, the equation is:

$$\sum_{i \neq s,\, r} \frac{L_i^\circ}{\beta_i}\left[1-\left(\frac{L_b}{L_b^\circ}\right)^{\beta_i}\right]=\frac{E_b P_b}{\pi}\,[L^\circ-L+S] \tag{20}$$

Other special cases are (a) single volatile component and soluble non-volatile component which is discussed in Perry,[1] and (b) two volatile components with the assumption that the non-volatile components do not alter the mole fractions of the volatile components in the still is covered in Robinson and Gilliland.[2] When either of these assumptions is made Equation (19) reduces to the same results obtained in the above two books.[1,2]

Illustrative Example

It is desired to separate three high-boiling organic acids from a soluble non-volatile material by steam-batch distillation. The initial mixture contains 80 moles of the acids and 20 moles of the non-volatile material. The organic acid mixture contains 30 moles of the most volatile acid and 25 moles of each of the other two. The distillation is to be carried out at 100° C. and at a total pressure of 200 mm. of mercury. At 100 C., the vapor pressures of the acids are 20, 14 and 8 mm. of mercury, and at equilibrium the mixture obeys Raoult's law. The vaporization efficiency for each component may be taken as 0.9. The distillation is to be carried out until 99 percent of the least volatile acid is vaporized. Calculate the moles of steam required.

Solution

The problem is solved by use of Equations (14) and (19). Equation (14) is also developed in the appendix.

1. **Calculation of L and L_T**

Take the least volatile acid as the base component. Then, the β's are as follows:

$$\beta_b=\beta_2=1.0;\ \beta_1=\left(\frac{E_1}{E_b}\right)\left(\frac{P_1}{P_b}\right)=\left(\frac{0.9}{0.9}\right)\left(\frac{20}{8}\right)=2.5$$

$$\beta_2=\left(\frac{E_2}{E_b}\right)\left(\frac{P_2}{P_b}\right)=\left(\frac{0.9}{0.9}\right)\left(\frac{14}{8}\right)=1.75;\ \beta_r=\left(\frac{E_r}{E_b}\right)\left(\frac{0}{8}\right)=0$$

The total moles remaining in the still at the end of the distillation is calculated by use of Equation (14) as follows:

$$L_T=L_1^\circ\left(\frac{L_b}{L_b^\circ}\right)^{\beta_1}+L_2^\circ\left(\frac{L_b}{L_2^\circ}\right)^{\beta_2}+L_3^\circ\left(\frac{L_b}{L_b^\circ}\right)^{\beta_2}+L_r^\circ\left(\frac{L_b}{L_b^\circ}\right)^{\beta_r}$$

and

$$L_T=(30)(0.01)^{2.5}+(25)(0.01)^{1.75}+(25)(0.01)^{1.0}+20$$

where the substitution $L_b/L_b^\circ=0.01$ $L_b^\circ/L_b^\circ=0.01$ has been made. The numerical value of L_T is

$$L_T = 20.2609, \text{ and } L = L_T - L_r^\circ = 0.2609$$

2. Evaluation of the Summation Term in Equation (19)

$$\sum_{i \neq s,\, r} \frac{L_i^\circ}{\beta_i}\left[1 - \left(\frac{L_b}{L_b^\circ}\right)^{\beta_i}\right] = \frac{30}{2.5}\left[1 - (0.01)^{2.5}\right] + \frac{25}{1.75}$$

$$\left[1 - (0.01)^{1.75}\right] + \frac{25}{1.0}\left[1 - (0.01)^{1.0}\right] = 50.887$$

3. Evaluation of the Logarithmic Term in Equation (19)

$$L_r^\circ \ln \frac{L_b^\circ}{L_b} = 20 \ln \frac{25}{(0.01)(25)} = 92.12$$

4. Calculation of the Moles of Steam Required

Substituting the above numerical values in Equation (19) gives

$$50.887 + 92.12 = \frac{E_b P_b}{\pi}[L^\circ - L + S]$$

$$143.01 = \frac{(0.9)(8)}{(200)}[80.0 - 0.2609 + S]$$

$$S = 3893 \text{ moles of steam}$$

APPENDIX

Development of Equations (19) and (20). A batch steam distillation is of the differential type in that the vapor produced is continuously withdrawn and condensed. The temperature of the still is maintained at a constant value by an indirect heat source.

The equations which describe the process are derived by utilizing over-all material balances during a time interval of Δt.

The accumulation of component i in the still during the time interval from t to $(t + \Delta t)$ is the number of moles of the component at time $(t + \Delta t)$ less the number of moles of the component at time t, which may be written as

$$\left.\begin{matrix}\text{accumulation of component} \\ \text{i in the still}\end{matrix}\right\} = L_T x_i \Big|_{t+\Delta t} - L_T x_i \Big|_t \tag{1}$$

By the theorem of the mean* of differential calculus the above reduces to

$$\left.\begin{matrix}\text{accumulation of component} \\ \text{i in the still}\end{matrix}\right\} = \Delta t \frac{d}{dt}(L_T x_i)\Big|_{t+\varepsilon\Delta t} \tag{2}$$

and

$$\left.\begin{matrix}\text{depletion of component} \\ \text{i in the still}\end{matrix}\right\} = -\Delta t \frac{d}{dt}(L_T x_i)\Big|_{t+\varepsilon\Delta t} \tag{3}$$

In the above expressions "i" does not correspond to steam (written $i \neq s$). Let the average rate of flow of vapor (volatile components plus steam) during the time interval (increment) Δt be denoted by $\bar{r}$, and the average value of the mole fraction of any component i in the vapor during the same period of time be designated $\bar{y}$. Then the depletion of component i from the still (or the appearance of i in the vapor) during the time Δt is equal to $\bar{y}_i \bar{r} \Delta t$. Then,

$$-\Delta t \frac{d(L_T x_i)}{dt}\Big|_{t+\varepsilon\Delta t} = \bar{y}_i \bar{r} \Delta t \tag{4}$$

or,

$$-\frac{d(L_T x_i)}{dt}\Big|_{t+\varepsilon\Delta t} = \bar{y}_i \bar{r} \tag{5}$$

Taking the limit as Δt approaches zero, equation (5) reduces to

$$-\frac{d(L_T x_i)}{dt} = y_i r \tag{6}$$

* This theorem states that the value of f(x) evaluated at $(x + \Delta x)$ is given by $f(x)\big|_{x+\Delta x} = f(x)\big|_x + \Delta x\, f'(x)\big|_{x+\varepsilon\Delta x}$. The value of ε is selected so that at the point $x + \varepsilon\Delta x$ the function f(x) has a slope equal to that of the chord connecting the points $\left(f(x)\big|_x, x\right)$ and $\left(f(x)\big|_{x+\Delta x}, x + \Delta x\right)$.

But,

$$r = \frac{d(V + S)}{dt} \text{ and } L_T x_i = L_i \tag{7}$$

Thus,

$$-\frac{dL_i}{dt} = y_i \frac{d(V + S)}{dt} \tag{8}$$

The variable V is related to L_T by an over-all material balance as follows:

$$L^\circ + L_r^\circ = L + L_r^\circ + V \text{ or } L_T^\circ = L_T + V \tag{9}$$

Therefore Equation (8) may be written

$$-\frac{dL_i}{dt} = y_i\left[-\frac{dL_T}{dt} + \frac{dS}{dt}\right] \tag{10}$$

For any component except steam

$$y_i = \frac{p_i}{\pi} = \frac{E_i P_i x_i}{\pi} = \frac{E_i P_i x_i L_T}{\pi L_T} = \frac{E_i P_i L_i}{\pi L_T} \tag{11}$$

where E_i is the vaporization efficiency of component i; it is defined as the actual partial pressure exerted by the component i divided by the equilibrium partial pressure ($P_i x_i$). It is assumed that Raoult's law is applicable. The efficiency, E, is adequately discussed in the Chemical Engineer's Handbook.[1] In the following equations E_i is taken to be independent of the level of liquid in the still (which represents an approximation). The solution of Equation (10) is facilitated by the specification of a base component, L_b. The relative volatilities, α, are calculated with respect to it ($\alpha_i = P_i/P_b$), and the degree of the distillation is also specified in terms of the base component. The volatile component with the lowest vapor pressure is usually taken as the base component.

Before integrating Equation (10), it is necessary to obtain an expression for L_T in terms of the L_i and L_b. When the members of Equation (10) are divided by the corresponding members for the base component, one obtains

$$\frac{dL_i}{dL_b} = \frac{y_i}{y_b} = \frac{E_i P_i L_i}{E_b P_b L_b} = \frac{E_i}{E_b}\,\alpha_i \frac{L_i}{L_b} = \beta_i \frac{L_i}{L_b} \tag{12}$$

where $\beta_i = \frac{E_i}{E_b}\alpha_i$. The integrated form is

$$L_i = L_i^\circ\left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} \tag{13}$$

and L_T is equal to the sum of the L_i terms, where $i \neq s$, or

$$L_T = \sum_{i \neq s} L_i^\circ \left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} \tag{14}$$

where the non-volatile components have been included (for $i = r$, $\beta_r = 0$, and $L_i^\circ = L_r^\circ$).

Returning to Equation (10) and replacing y_i by its equivalent, given by Equation (11), one obtains for the base component

$$L_T \frac{dL_b}{L_b} = \frac{E_b P_b}{\pi}\left[dL_T - dS\right] \tag{15}$$

The right-hand side of this equation may be integrated directly to give

$$\frac{E_b P_b}{\pi}\left[(L_T - L_T^\circ) - (S - 0)\right] = \frac{E_b P_b}{\pi}\left[L - L^\circ - S\right] \tag{16}$$

With the aid of Equation (14), the left-hand side of Equation (15) may be integrated.

$$\int_{L_b^\circ}^{L_b} L_T \frac{dL_b}{L_b} = \int_{L_b^\circ}^{L_b} \sum L_i^\circ \left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} \frac{dL_b}{L_b^\circ} + \int_{L_b^\circ}^{L_b} L_r^\circ \left(\frac{L_b}{L_b^\circ}\right)^{\beta_r} \frac{dL_b}{L_b} \quad (17)$$

It is readily shown that the integrated expression is

$$\int_{L_b^\circ}^{L_b} L_T \frac{dL_b}{L_b} = \sum_{i \neq s, r} \frac{L_i^\circ}{\beta_i} \left[\left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} - 1 \right] + L_r^\circ \ln \frac{L_b}{L_b^\circ} \quad (18)$$

Therefore the desired integrated form of Equation (15) is

$$\sum_{i \neq s, r} \frac{L_i^\circ}{\beta_i} \left[1 - \left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} \right] + L_r^\circ \ln \frac{L_b^\circ}{L_b} = \frac{E_b P_b}{\pi} \left[L^\circ - L + S \right] \quad (19)$$

For the special case where the non-volatile components do not alter the mole fractions of the volatile components in the still, the development is similar to that given above. The final relationship obtained is

$$\sum_{i \neq s, r} \frac{L_i^\circ}{\beta_i} \left[1 - \left(\frac{L_b}{L_b^\circ}\right)^{\beta_i} \right] = \frac{E_b P_b}{\pi} \left[L^\circ - L + S \right] \quad (20)$$

Application of Equations (19) and (20) To the Special Cases Considered by Other Authors

For the special case of one single volatile component (component "b") Equation (19) reduces to

$$L_b^\circ - L_b + L_r^\circ \ln \frac{L_b}{L_b^\circ} = \frac{E_b P_b}{\pi} \left[L_b^\circ - L_b + S \right]$$

since $\beta_b = 1$, and $L_b^\circ = L^\circ$, $L_b = L$. This equation may be rearranged to the same form as that shown by Perry.[1]

When all of the volatile components are vaporized ($L_b = L = 0$), Equation (20) reduces to

$$\sum_{i \neq s, r} \frac{L_i^\circ}{\beta_i} = \frac{E_b P_b}{\pi} \left[L^\circ + S \right]$$

For the case where $E_i = E_b = 1.0$, and for two components ($i = 1$ and $i = b$), this expression reduces to

$$\frac{L_i}{\alpha_i} + \frac{L_b}{\alpha_b} = \frac{P_b}{\pi} \left[L^\circ + S \right]$$

This equation is equivalent to the one given by Robinson and Gilliland.[2]

NOTATION

E_i = Vaporization efficiency of component i; $E_i = \frac{p_i}{P_i x_i}$, where the symbols on the right are defined below.

L = Moles of volatile components in the still at any time. when $t = 0$, $L = L^\circ$.

L_r° = Moles of non-volatile components in the still at all times.

$L_T = L + L_r^\circ$, the total moles of liquid in the still at any time.

P_i = Vapor pressure of the pure component i at the temperature of the still.

p_i = Partial pressure of component i in the vapor above the liquid at any time.

S = Moles of steam used during the time interval of $t = 0$ to $t = t$.

$\bar{r}, r$ = Moles of vaporized volatile components plus steam entering the condenser per unit time. $\bar{r}$ represents the average value during a given increment of time. r represents the instantaneous value at any time t.

t = Process time; initially $t = 0$.

Δt = An increment of time.

V = Moles of volatile components vaporized during time interval $t = 0$ to $t = t$.

x_i = Mole fraction at any time of any component "i" in the liquid in the still.

$\bar{y}_i, y_i$ = Mole fraction at any time of any component "i" in the vapor. $\bar{y}_i$ is an average value during a given time interval (Δt). y_i is an instantaneous value.

Subscripts

b = The volatile component selected as the base component.

i = Any one of the components unless otherwise specified.

r = Non-volatile components.

s = Steam.

Greek Letters

α = Relative volatility.

$\alpha_i = P_i/P_b$.

$\beta_i = \frac{E_i}{E_b}\alpha_i$.

ε = A constant, selected as indicated in the context.

π = Total pressure of the distillation.

Σ = Summation symbol.

$\sum_{i \neq s}$ = Summation over all components except steam.

$\sum_{i \neq s, r}$ = Summation over all components except steam and non-volatile components.

$L_T x_i \Big|_t$ = Value of $L_T x_i$ at time t.

About the Authors

Holland

Welch

C. D. HOLLAND is an associate professor at Texas A & M, College Station, Texas, where he does graduate and undergraduate teaching, and directs research projects in chemical engineering. He received his B.S. degree in chemical engineering from North Carolina State College in 1943, then spent the next four years in the Navy. In 1947 he joined Burlington Mills Corp. as a junior engineer, then in 1948 started his graduate work at Texas A & M where he received his Ph.D. degree in 1953 in chemical engineering. In 1953 he joined the A & M faculty.

•

N. E. WELCH is a graduate student at Texas A & M College, College Station, where he is a teaching assistant. From September to November 1954, Welch worked in the Research and Development department of Columbia Southern Chemical Corp., Corpus Christi, then he spent the next two years in the U. S. Air Force as a chemist in the Research and Development department. Welch received both his B.S. and M.S. degrees in chemical engineering from Texas A & M.

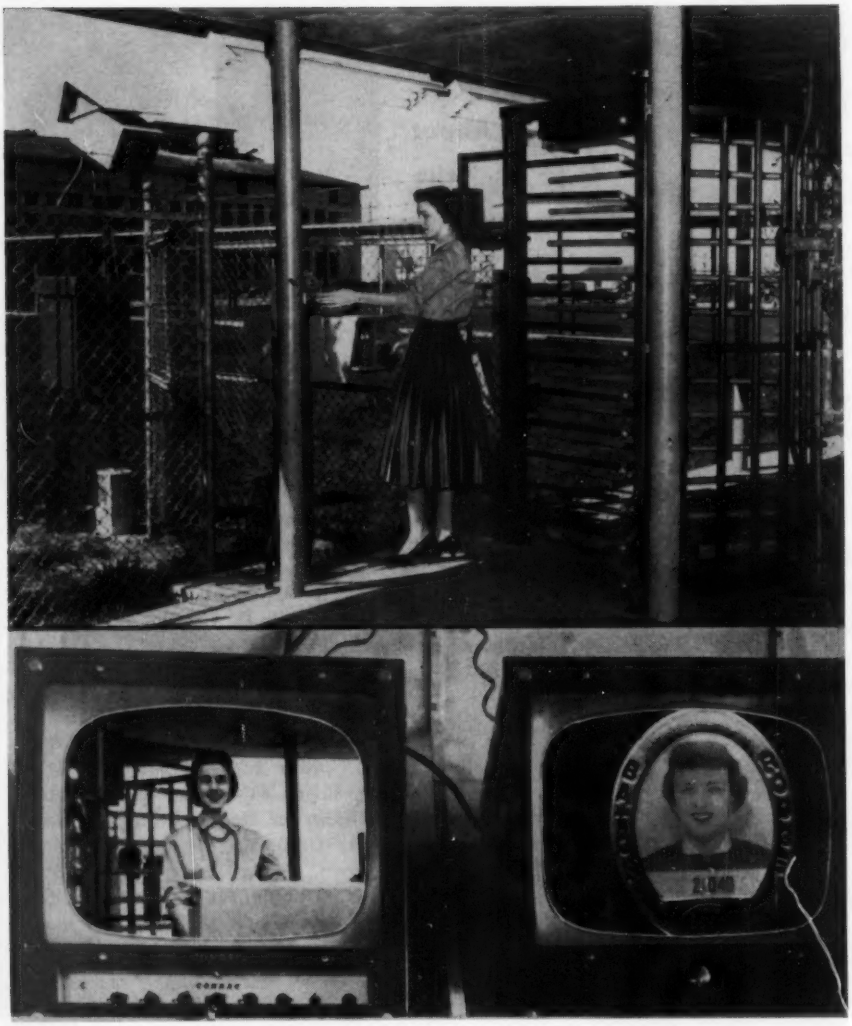
ACKNOWLEDGMENTS

This work was supported in part by the Texas Engineering Experiment Station. This aid is gratefully acknowledged.

LITERATURE CITED

[1] Perry, J. H., Editor-in-Chief, "Chemical Engineer's Handbook," Third Edition, McGraw-Hill Book Company, Inc., New York, Toronto and London, see section on "Distillation" by Carey, S. S., 580-583 (1950).

[2] Robinson, C. S., and Gilliland, E. R., "Elements of Fractional Distillation," Fourth Edition, McGraw-Hill Book Company, Inc., New York, Toronto and London, 111-115 (1950).



An employe of the Baton Rouge refinery (Dixie Smith) demonstrates how the electronic entrance operates.

TV Stands Guard

Here a new method is used to guard the employe entrance of a refinery. TV and remote control are used so that no watchman is seen.

TWO CAMERAS of a closed-circuit TV system are used to monitor an employe entrance of the Baton Rouge refinery for Esso Standard Oil Company. The cameras flash their pictures to the refinery's guard headquarters where the guard on duty controls the turnstile entrance.

Upon approaching the entrance, the employe sees no watchman. He presses a buzzer to alert the guard and then presents his badge before one of the TV cameras nearby. A second and larger camera views the employe and the general area.

After an employe is identified, the guard pushes a button which releases the turnstile and a green light lets the employe know he may enter. The gate stays open only for the time needed for one person to enter, but the larger camera shows enough of the area for the guard to make sure no unauthorized person enters. ##

Solubility of Water in Hydrocarbons

Here, on one convenient graph, are the solubility data for 17 different pure hydrocarbons and petroleum fractions.

W. F. Hoot*, A. Azarnoosh and John J. McKetta
The University of Texas
Austin

QUITE OFTEN the process engineer requires solubility information in the hydrocarbon-water systems. Some reasons are as follows: to estimate the water content of refinery process streams at saturation, to estimate the possibility of the build-up of a water phase in a hydrocarbon fractionating tower, or to calculate the fractionation of water from a hydrocarbon stream by distillation. Gester[3] describes a commercial installation for the dehydration of a hexane stream by distillation drying. A more familiar example of distillation drying is in the sulfuric acid alkylation process wherein water in the wet feed to the deisobutanizer tower distills overhead with the propane-isobutane stream.

The solubility data for water in hydrocarbons were obtained from the literature and from experimental work in this laboratory. Tables 1 and 2 list the hydrocarbons and the data source. These data are for the saturation of the pure hydrocarbon or the petroleum fraction with water at a given temperature under the equilibrium vapor pressure of the co-existing vapor, hydrocarbon and water phases.

The data are shown on next page.

TABLE 1

Source of Data for Solubility of Water in Pure Hydrocarbons

INVESTIGATOR	Hydrocarbon
Black, Joris, and Taylor[1]	butadiene-1,3 isobutene n-butane i-butane n-pentane i-pentane n-hexane n-heptane n-octane benzene cyclohexane butene-1 butene-2 heptene-1 hexadiene-1,5
Brooks, Haughn and McKetta[2]	1-butene
Gester[3]	n-hexane
Groschuff[5]	benzene
Hibbard and Schalla[6]	benzene toluene xylene cyclohexane
Kobayashi and Katz[7]	propane
Lane[8]	styrene
McKetta and Katz[9]	n-butane
McKetta and Co-Workers[10]	propane i-butane hexadiene-1,5 heptene-1 cyclohexane n-octane
Poettman and Dean[11]	propane
Reamer, Olds, Sage and Lacey[12]	n-butane

with mole percent water plotted against the reciprocal of the absolute temperature. A straight line was obtained for each of the pure hydrocarbon and petroleum fractions. The data show that the type of hydrocarbon has considerably more effect on the solubility than does the molecular weight.

LITERATURE CITED

[1] Black, Joris, and Taylor, J. Chem. Phys., 16, 537 (1948).
[2] Brooks, Haughn, and McKetta, PETROLEUM REFINER, 34, No. 8, 129 (1955).
[3] Gester, Chem. Eng. Prog., 43, 117 (1947).
[4] Griswold and Kasch, Ind. Eng. Chem., 34, 804 (1942).
[5] Groschuff, Z. Electrochem., 17, 348 (1911).
[6] Hibbard and Schalla, "Solubility of Water in Hydrocarbons," Natl. Advisory Comm. Aeronautics, NACA Res. Memo. RM E52 D24, July 10, 1952.
[7] Kobayashi and Katz, Ind. Eng. Chem., 45, 440 (1953).
[8] Lane, Ind. Eng. Chem. Anal. Ed., 18, 295 (1946).
[9] McKetta and Katz, Pet. Tech. (AIME), 10, Tech. Pub. No. 2123 (1947).
[10] McKetta and Co-Workers, unpublished data.
[11] Poettman and Dean, PETROLEUM REFINER, 25, 635 (1946).
[12] Reamer, Olds, Sage and Lacey, Ind. Eng. Chem., 36, 381 (1944).

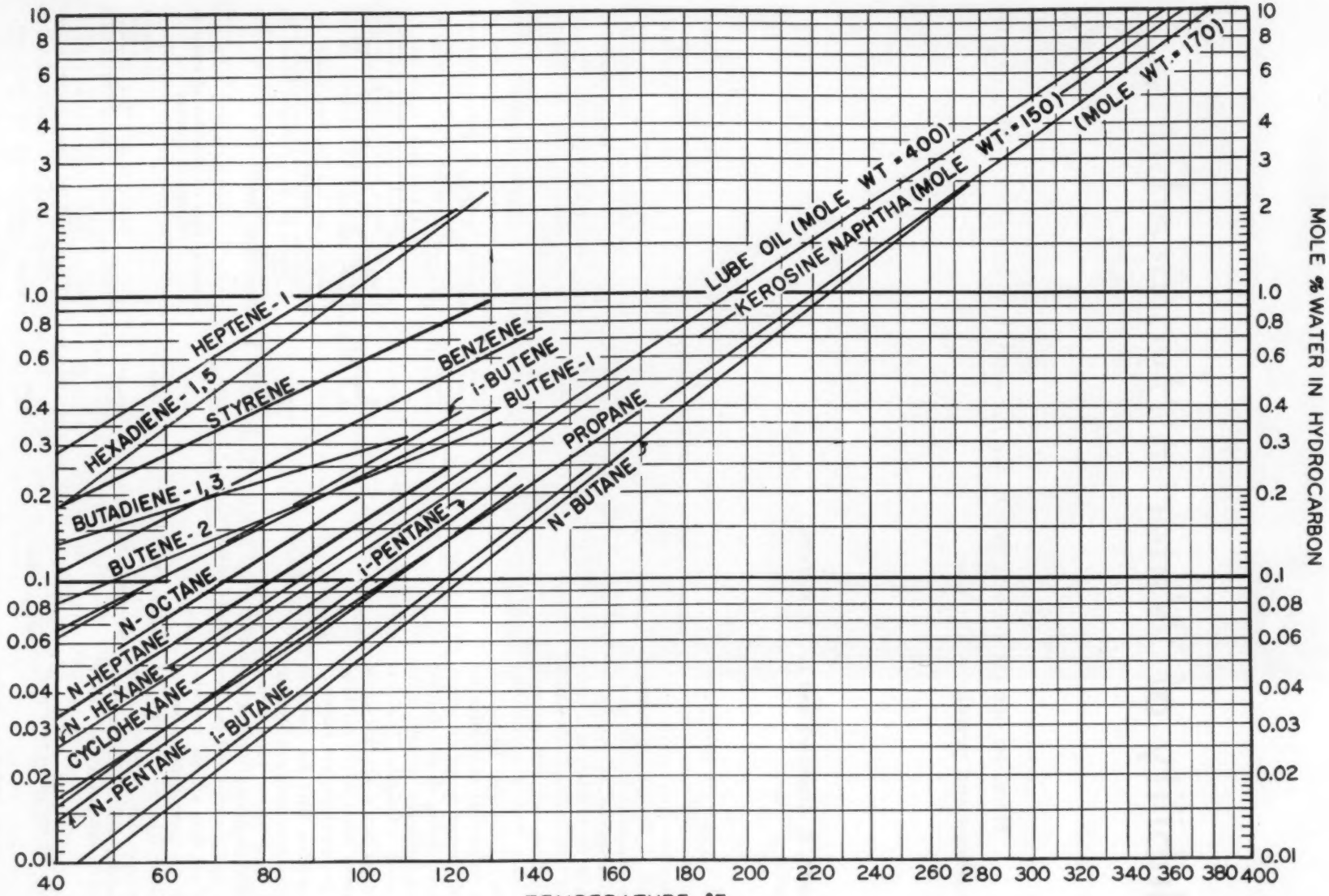
TABLE 2

Source of Data for Solubility of Water in Petroleum Fractions

Investigator	Hydrocarbon	Gravity, °API	Mole Weight	Watson Characterization Factor
Griswold and Kasch[4]	naphtha	54.3	147	12.2
	kerosine	42.0	173	11.8
	SAE 20 lube oil	29.3	434	12.4
Groschuff[5]	kerosine	47.2	170	12.0
	lube oil	28.7	350	11.9

Graph on Page 256

* Dr. Hoot is with the Research and Development department, American Oil Company, Texas City, Texas.



SOLUBILITY OF WATER IN HYDROCARBONS

Domestic Crudes Contain Less Sulfur

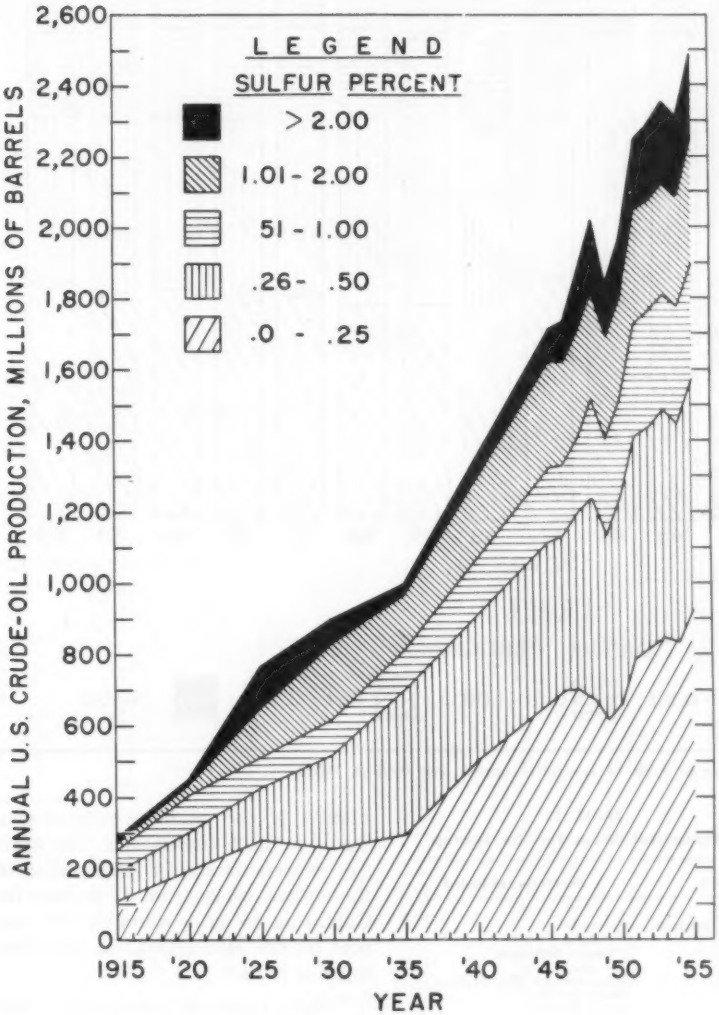


FIGURE 1

The sulfur content of crude oil is useful information in deciding the type of processing which will be required. These analyses will tell you what to expect.

E. M. Shelton, C. M. McKinney and O. C. Blade
Bureau of Mines
Bartlesville, Okla.

THE PROPORTION of high-sulfur (more than 0.50 percent) to low-sulfur (less than 0.50 percent) crude oil production reached a maximum of 0.63 in 1948 after a gradual but definite increase between 1935 and 1947. During the next seven years the proportion decreased, reaching 0.58 in 1955. The major producing fields that contributed to the decrease in proportion of high- to low-sulfur crude oils were in Scurry County in West Texas area and in the Williston Basin in the Rocky Mountain area.

The trends of supply of high-sulfur crude oils in the U. S. from 1915 to 1946 were reported by Smith and Blade.[6, 7, 8] Some of the data were revised and included with 1947 production data in a subsequent article by Blade.[2] This paper reports the results of a continuation of the study by an analysis and summary of data for the years 1948-55.

Sulfur contents of the crude petroleum and production data were secured for approximately 700 U. S. oil fields. The information was obtained from Bureau of Mines routine crude oil analyses, AIME volumes on production statistics,[1] and trade publications[5] for each of the years 1948-55. Production figures for fields produc-

Domestic Crudes Contain Less Sulfur . . .

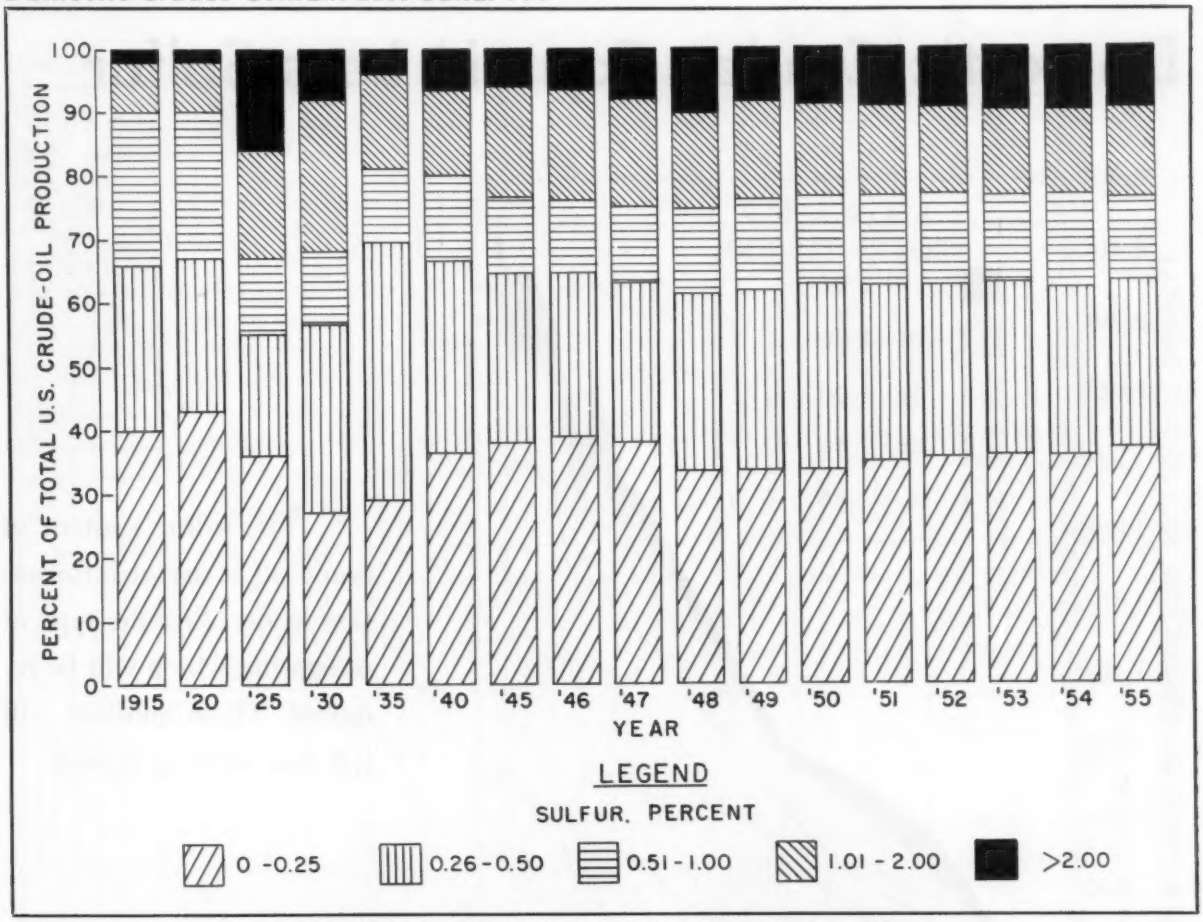


FIGURE 2—The ratio of high to low-sulfur crudes was 0.58 in 1955.

ing from two or more formations were listed by producing formation if the sulfur contents of the crude oils fell in two or more groups.

The data were tabulated according to field location within each of the nine geographical areas. These areas are defined in Table 1.

Production data for the fields in each area were then arranged in groups according to sulfur content of the crude oils as follows:

0—0.25 percent
0.26—0.50 percent
0.51—1.00 percent
1.01—2.00 percent
Greater than 2.00 percent

The percentage distribution of U. S. crude-oil production within each sulfur-content group was computed by year for each of the nine geographical areas and for the entire U. S. This percentage distribution was assumed to apply to all production in the respective areas since the data represent from 74 percent (1955) to 80 percent (1948) of the crude petroleum produced in the United States. The average representation of production of the regions varies from 95 percent for California to approximately 50 percent for the Michigan-Lima area during this period.

TABLE 1
Geographical Areas for the Survey

AREA	Sections Included
California	.....
Rocky Mountain	Colorado
	Montana
	Western Nebraska
	Nevada
	Northwestern New Mexico
	North Dakota
	South Dakota
	Utah
	Wyoming
Gulf Coast	Southern Louisiana
	*Texas Districts 2, 3, & 4
West Texas—Southeastern New Mexico	Texas Districts 7C and 8
	New Mexico Counties Lea, Eddy and Chaves
Mid-Continent	Arkansas
	Kansas
	Northern Louisiana
	Missouri
	Eastern Nebraska
	Oklahoma
	Texas Districts 1, 5, 6, 7B, 9 and 10
Illinois—Indiana—Western Kentucky	.....
Michigan—Lima	Michigan and Lima—grade crudes from Western Ohio
Appalachian	Eastern Kentucky
	Eastern Ohio
	New York
	Pennsylvania
	Tennessee
	Virginia
	West Virginia
Southeastern	Alabama
	Florida
	Mississippi

* Railroad Commission of Texas Districts.

Yearly crude-oil production data for the areas and for the U. S. were taken from the Bureau of Mines Minerals Yearbooks[3] and the Bureau of Mines Monthly Petroleum Statements.[4] Each of 500 of the fields for which data were used produced in excess of 2500 barrels per day during at least one of the years covered by the study. The remaining 200 fields were included to provide better representation for some of the areas having few or no large fields; that is, the Illinois-Indiana-western Kentucky, Michigan-Lima, and Appalachian areas.

The annual production of crude oil in the U. S. from 1915 to 1955, grouped according to sulfur content, is illustrated in Figure 1. The percent-

TABLE 2—Annual Crude Oil Production

AREA	Year	Percent of U. S.	MILLION BARRELS					
			SULFUR, WEIGHT PERCENT					
			0–0.25	0.26–0.50	0.51–1.00	1.01–2.00	>2.00	Total
CALIFORNIA	1948	16.83	26.2	72.1	81.2	129.1	31.5	340.1
	1949	18.08	23.3	74.3	73.6	132.3	29.4	332.9
	1950	16.60	21.1	77.2	69.8	133.4	26.1	327.6
	1951	15.77	20.5	80.6	76.7	143.0	33.8	354.6
	1952	15.70	18.3	80.4	77.5	141.9	41.4	359.5
	1953	15.49	16.5	77.0	83.3	138.9	49.4	365.1
	1954	15.37	16.2	75.6	80.0	135.4	48.7	355.9
	1955	14.28	19.3	74.2	81.5	133.7	46.0	354.7
ROCKY MOUNTAIN	1948	4.09	16.5	.1	20.9	20.7	24.6	82.8
	1949	4.43	18.0	.3	28.4	20.4	14.5	81.6
	1950	4.84	21.0	.9	28.3	19.7	25.6	95.5
	1951	4.86	27.1	1.1	30.6	22.0	28.4	109.2
	1952	4.99	30.6	2.4	32.2	23.9	25.2	114.3
	1953	6.15	45.4	6.4	32.8	27.2	33.0	144.8
	1954	7.35	57.8	12.1	32.9	29.3	38.1	170.2
	1955	7.69	66.4	15.5	38.0	31.2	39.9	191.0
GULF COAST	1948	20.42	359.6	49.2	3.6	....	....	412.4
	1949	19.30	301.1	51.2	3.2	....	....	355.5
	1950	18.44	302.3	58.5	3.2	....	....	364.0
	1951	19.05	359.8	64.6	3.8	....	....	428.2
	1952	18.85	359.1	68.5	4.0	....	....	431.6
	1953	18.74	360.6	76.9	4.3	....	....	441.8
	1954	17.62	326.8	77.1	4.0	....	....	407.9
	1955	18.03	357.8	86.2	4.0	....	....	448.0
WEST TEXAS–SOUTHEASTERN NEW MEXICO	1948	15.96	48.9	50.0	30.0	131.1	62.4	322.4
	1949	15.03	44.2	43.7	30.5	105.6	52.9	276.9
	1950	16.91	85.1	49.6	35.8	106.2	57.0	333.7
	1951	19.29	131.5	64.5	49.4	122.3	66.0	433.7
	1952	19.93	158.4	65.4	47.8	117.8	67.0	456.4
	1953	19.54	166.5	66.2	47.5	114.0	66.4	460.6
	1954	19.75	170.9	65.1	45.0	111.5	64.7	457.2
	1955	20.07	182.5	70.6	46.2	128.6	70.7	498.6
MID-CONTINENT	1948	34.40	136.7	351.2	115.7	25.0	66.3	694.9
	1949	34.44	136.4	316.2	108.5	26.6	46.7	634.4
	1950	35.07	152.5	346.2	114.9	30.0	48.5	692.1
	1951	34.04	167.3	371.0	135.0	31.4	60.3	765.0
	1952	33.68	170.2	360.8	144.8	31.9	63.4	771.1
	1953	33.52	178.4	374.2	134.2	34.0	69.4	790.2
	1954	33.02	173.6	340.4	158.4	32.7	59.4	764.5
	1955	32.83	199.9	358.2	137.2	57.2	63.3	815.8
ILLINOIS–INDIANA–WESTERN KENTUCKY	1948	3.92	47.8	31.5	....	....	....	79.3
	1949	4.43	50.8	30.8	....	....	....	81.6
	1950	4.14	46.0	35.7	....	....	....	81.7
	1951	3.62	46.7	34.7	....	....	....	81.4
	1952	3.60	46.8	35.7	....	....	....	82.5
	1953	3.47	47.8	33.8	....	....	....	81.6
	1954	3.88	56.0	33.8	....	....	....	89.8
	1955	4.26	66.7	39.1	....	....	....	105.8
MICHIGAN–LIMA	1948	.85	.2	5.3	11.5	....	....	17.0
	1949	.91	.2	4.9	11.6	....	....	16.7
	1950	.81	.2	4.8	10.9	....	....	15.9
	1951	.63	.2	4.1	9.7	....	....	14.0
	1952	.59	.3	4.0	9.1	....	....	13.4
	1953	.52	.4	3.8	8.3	....	....	12.5
	1954	.53	.6	3.9	7.6	....	....	12.1
	1955	.46	.6	3.9	6.9	....	....	11.4
APPALACHIAN	1948	1.23	24.7	....	....	....	....	24.7
	1949	1.27	23.4	....	....	....	....	23.4
	1950	1.19	23.5	....	....	....	....	23.5
	1951	1.02	22.9	....	....	....	....	22.9
	1952	.99	22.8	....	....	....	....	22.8
	1953	.96	22.6	....	....	....	....	22.6
	1954	.91	21.0	....	....	....	....	21.0
	1955	.81	20.1	....	....	....	....	20.1
SOUTHEASTERN	1948	2.30	16.2	....	11.9	....	18.4	46.5
	1949	2.11	17.1	....	12.0	....	9.8	38.9
	1950	2.00	13.9	....	11.1	....	14.5	39.5
	1951	1.72	11.3	....	10.6	....	16.7	38.6
	1952	1.67	10.3	....	10.6	....	17.3	38.2
	1953	1.61	9.2	....	11.4	....	17.3	37.9
	1954	1.57	8.1	....	12.0	....	16.3	36.4
	1955	1.57	8.9	....	12.4	....	17.8	39.1
TOTAL UNITED STATES	1948	100.00	676.7	559.4	274.9	305.9	203.2	2,020.1
	1949	100.00	614.5	521.4	267.8	284.9	153.3	1,841.9
	1950	100.00	665.6	572.9	274.0	289.3	171.7	1,973.5
	1951	100.00	787.3	620.6	315.8	318.7	205.2	2,247.7
	1952	100.00	816.8	617.2	326.0	315.5	214.3	2,289.8
	1953	100.00	847.4	638.3	321.8	314.1	235.5	2,357.1
	1954	100.00	831.0	608.0	339.9	308.9	227.2	2,315.0
	1955	100.00	922.2	647.7	326.2	350.7	237.7	2,484.5

Domestic Crudes Contain Less Sulfur . . .

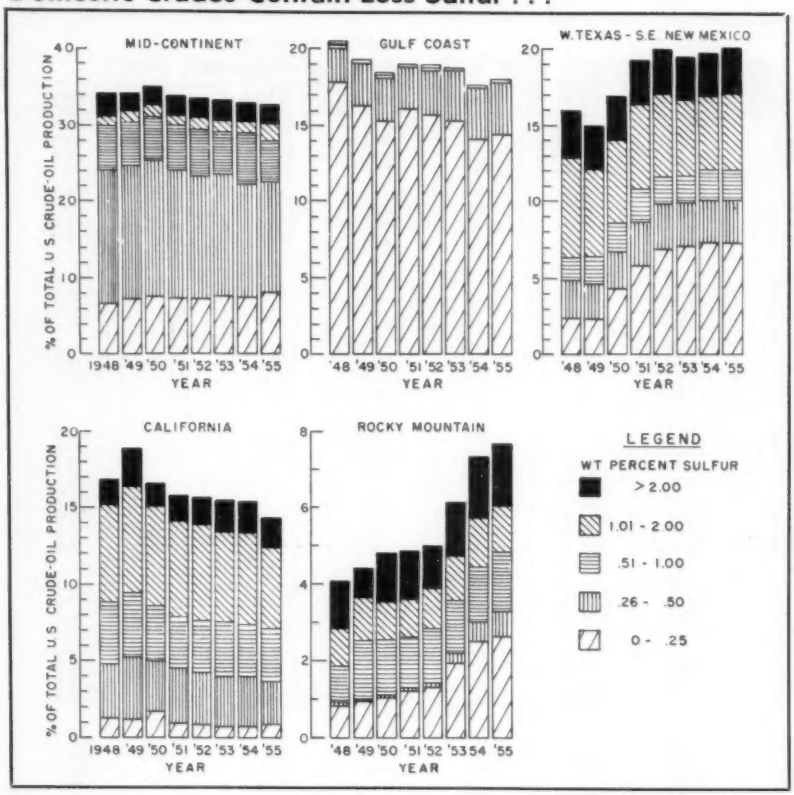


FIGURE 3—The reduction of sulfur content in the total crude supply may be attributed to the increased production of low-sulfur crude in the West Texas-Southeastern New Mexico area.

age distribution according to sulfur content during the same years is illustrated in Figure 2.

One noticeable trend is the relative increase in production of low sulfur (less than 0.50 percent) crude oil between 1948 and 1955. This trend represents a reversal to that previously reported by Smith and Blade,[8] who found that the proportion of high- to low-sulfur crude oil increased from 0.42 in 1935 to 0.57 in 1947. The present study revealed the ratio reached a maximum of 0.63 in 1948 and subsequently decreased to 0.58 in 1955. The major contributing factors were the Scurry County (West Texas) and Williston Basin (Rocky Mountain) developments where most of the crude oil contains less than 0.50 percent sulfur.

The percentage distribution of crude oil production according to sulfur content is illustrated in Figure 3 for the five geographical areas contributing the bulk of U. S. production. Four areas are not included because of negligible changes in percentage distribution. They were considered in detail in previous reports.[6, 7]

The two most evident trends in Figure 3 are the relative increase in production of low-sulfur crude oil in the West Texas-Southeast New Mexico area commencing in 1949 and continuing until 1954, and the increases in total production and relative increase of low-sulfur crude oil in the Rocky Mountain area throughout the 1948 to 1955 period.

Table 2 shows the annual crude-oil production in million barrels for 1948-55, in each sulfur group for the nine areas and the entire U. S. Also shown are the percentages of U. S. crude oil productions for the areas for each of the years. A tabulation showing the fields that were used to develop the data presented in this report, production during 1950 and 1955, and sulfur contents of the crude oil, may be obtained from the authors.

LITERATURE CITED

[1] The American Institute of Mining and Metallurgical Engineers, Statistics of Oil and Gas Development and Production, volumes covering years 1948-54 (1949-55).

[2] Blade, O. C., High-Sulfur Crude Oils—Trends in Supply, II U. S. Data of 1945-47, Petroleum Refiner, 28, Mar. 1949, 151-152.

[3] Bureau of Mines, Minerals Yearbooks, 1948-53, Petroleum and Petroleum Products Chapters.

[4] Bureau of Mines, Mineral Industry Surveys, Monthly Petroleum Statements 308-399, 1948-55.

[5] *Oil and Gas Journal*, 54, Jan. 30, 1956, 180-185.

[6] Smith, H. M., and Blade, O. C., High-Sulfur Crude Oils of the United States—Trends in Supply, Proceedings American Petroleum Institute, Section III, Refining, 1947, 119-140.

[7] Smith, H. M., and Blade, O. C., Trends in Supply of High-Sulfur Crudes in the U. S., *Oil and Gas Journal*, 48, Nov. 29, 1947, 73-78.

[8] Smith, H. M., and Blade, O. C., Trends in Supply of High-Sulfur Crudes in the U. S., Petroleum Refiner, 27, May 1948, 101-110.

About the Authors

E. M. SHELTON is a statistical assistant at the Bureau of Mines Petroleum Equipment Station where she assists in the preparation of reports on crude oil and fuels analysis. Miss Shelton has been employed at the Bartlesville Petroleum Equipment Station since 1945.

C. M. McKINNEY is a chemical engineer at the Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla., where he does analysis of crude oil and petroleum fuels. McKinney joined the Bureau of Mines in 1942 at Bartlesville after receiving his B.S. degree in petroleum engineering from the University of Oklahoma in 1940. From 1944 to 1945 he was assigned to the Bureau's Washington office, from 1945 to 1946 he was in the Navy, and in 1946 he returned to Bartlesville.

O. C. BLADE is a petroleum chemist for the Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla., where he compiles data for reports in cooperation with the API on motor, aviation, diesel, and burner fuels. Blade received his B.A. degree from the University of Colorado in 1926, and since 1930 has been a research chemist at Bartlesville. He is the author of numerous papers.

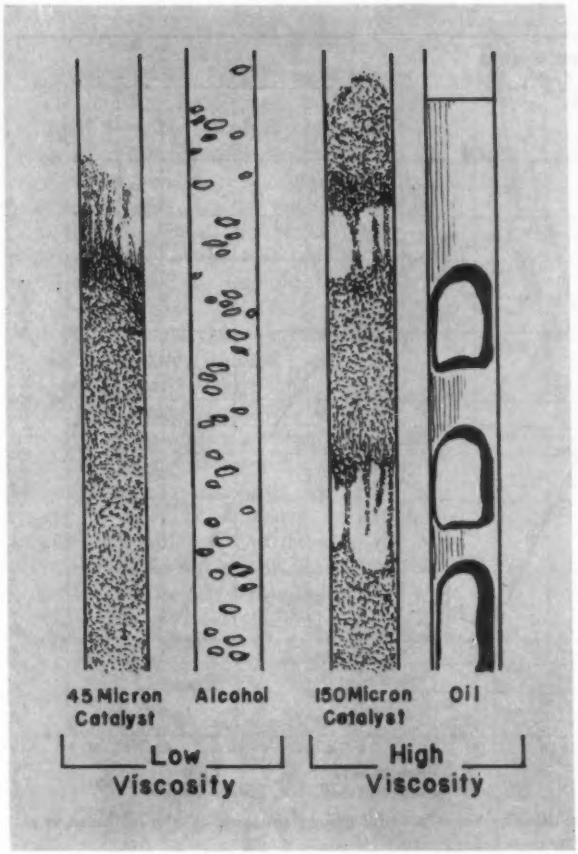


FIGURE 1—Bubble formation due to gas being passed through liquid and fluid solids. This suggests for fluid-solid systems a property similar to viscosity in liquids.

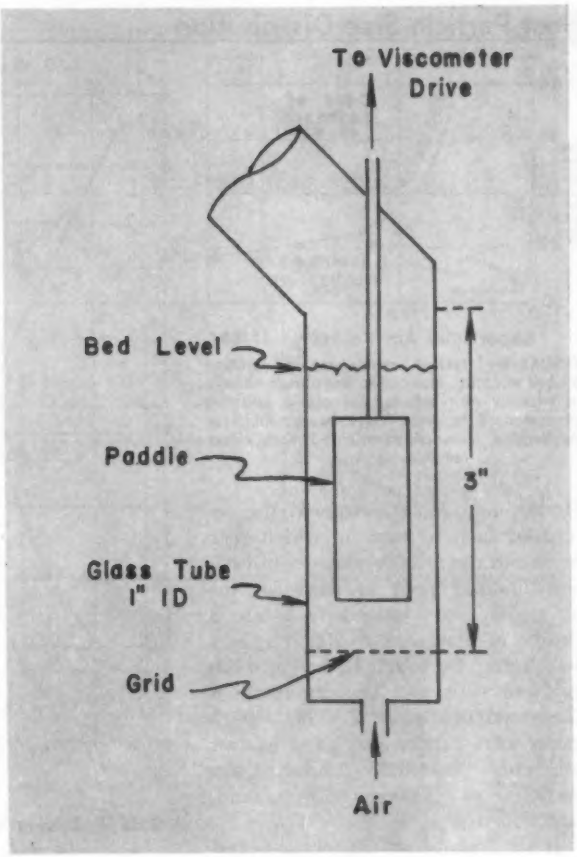


FIGURE 2—Test apparatus for measuring the relative viscosity of various fluidized beds in terms of the torque weight required to rotate the paddle.

Fluid Catalyst Design Data—Part 2

Find Best Particle Size Distribution

Part 2 discusses the influence of particle size distribution on fluidization characteristics. Part 1—"How Solid Catalysts Behave"—which appeared in the April issue, analyzed the commonly observed flow characteristics of powders, sands, and granular solids in general. These were correlated with specific, experimentally measured, pseudo-physical properties.

Frederick A. Zenz, Roslyn Harbor, Long Island, N. Y.

PARTICLE SIZE distribution as it affects desirable fluidization characteristics is still a qualitative field. Here the published data are drawn together into a logical pattern that permits a certain degree of quantitative treatment.

Optimum particle size distribution is found to approach the skew probability form resulting in an approximately eleven-fold variation in particle size.

The Bed Viscosity Concept-Uniform Size Particles. The passage of gas upwards through a fluidized column of solids is similar in appearance to the upward flow of gases through liquids. Observations of this type have shown that gas passes through beds of small size solids of good fluidity in a manner analogous to the upward flow of gas through a liquid of low viscosity, while viscous liquids when aerated show the same type of slugging observed with coarse solids; Figure 1 illustrates these flow characteristics. This suggests that fluid-solid systems could perhaps be classified in terms of a property similar to viscosity in liquids and that this pseudo viscosity might be a fundamental correlant of slugging, good fluidity, or other bed characteristics. Matheson,

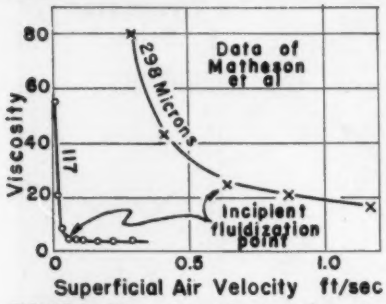


FIGURE 3—Effect of particle size and aeration on bed viscosity. Notice the less abrupt change in viscosity with aeration for coarse particles as compared to fines. Once passed incipient fluidization, increased aeration has little effect on bed viscosity.

Herbst, and Holt[6] presented the results of such a study in which they measured the relative viscosity of various fluidized beds in terms of the torque weight required to rotate a paddle of fixed size at 200 rpm in a 3-inch deep by 1-inch ID bed of solids fluidized with air. The apparatus is illustrated in Figure 2. The experiments were carried out using narrow size cuts (essentially uniform size particles) of cracking catalysts, sand, and iron oxides.

It was found that the torque necessary to rotate the paddle in an unaerated bed was extremely high but dropped rapidly with the addition of aeration. At aeration rates greater than required for incipient fluidization, the torque or viscosity decreased very slowly and remained essentially constant and independent of aeration rate. The rate of change of viscosity with aeration was found to be less abrupt with coarse particles as compared to fines, but the incipient fluidization point in the viscosity curves was in every case quite evident. The relative viscosity of the beds was found to increase with particle size and particle density. Figure 3 illustrates typical data on the effect of aeration on two different particle sizes.

The characterizing viscosity of the beds was taken as the value obtained at the point of incipient fluidization. These characteristic values were found to correlate fairly well the observed L/D ratios at which the particles exhibited slugging in small tubes.

It was theorized that the bed viscosity measured in this manner should be a function of the volume within which the particles can freely move. Since this freedom for movement would be greater the more loose the packing density of the dense phase, it seemed reasonable to expect a correlation of viscosity with bed expansion or ratio of settled bulk density to bed density just prior to incipient fluidization. Matheson et al therefore proposed a correlation of L/D at slugging to bed expansion and particle density by going through an intermediate viscosity factor. Their curves are shown in Figure 4.

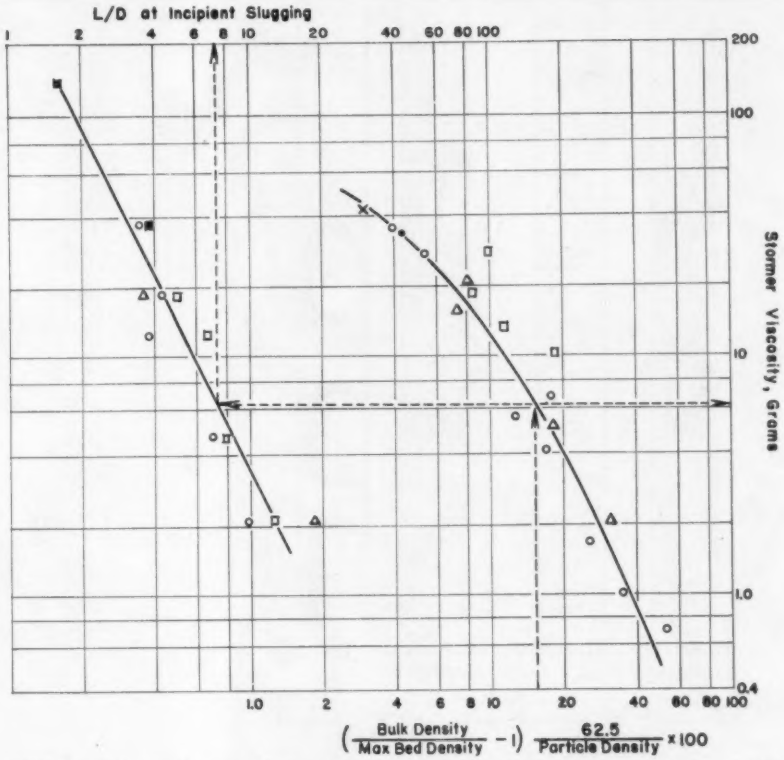


FIGURE 4—Relation between density, viscosity, and slugging characteristics after Matheson, et al.

It would appear from Figure 4 that though bed viscosity may be a fundamental concept, its correlation with the more tangible property of bed expansion may make it more a dependent rather than independent variable in the analysis of fluidity. However, the concept in its extension to two and more component systems leads to several interesting conclusions.

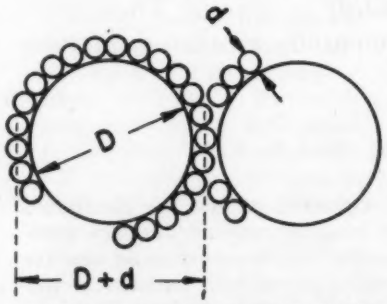


FIGURE 5—Two-component model. Showing small particles coating the larger particles and thus reducing the friction between the larger particles.

Bed Viscosity of Two-Component Systems. In order to explore the effect of particle size distribution on bed viscosity Matheson et al measured the torque for various fluid beds made up of two component blends of different narrow cuts of synthetic cracking catalyst. The results showed that relatively small amounts of fines added to a coarse cut decrease the viscosity markedly. Conversely, the addition of a relatively large amount of coarse material to a bed of fine particles has little effect upon its viscosity.

It was concluded that in a bed of coarse particles the presence of more fines than are necessary to keep the coarse particles from interlocking, has a minor effect on the bed viscosity. The rate of change of bed viscosity with composition shows a decided break point at the minimum required fines concentration to prevent this interlocking of coarse particles. The

break point is more abrupt the smaller the ratio of diameter of fines to diameter of coarse particles.

Trawinski[7] attempted an analytical solution for this point of minimum fines concentration. He assumed the viscosity to be due to rubbing of coarse particles against each other. The introduction of fines between the coarse grains would then act as a lubricant reducing the friction between the coarse solids and thereby reducing the bed viscosity. According to this model, the minimum concentration of fines would be that quantity required to coat each coarse particle with a mono layer of fines. Treating the particles as perfect spheres, consider a two component bed compased of fines of diameter d, and coarse of diameter D, as depicted in Figure 5. The fractional change in combined particle volume due to the additional film of fines is then

$$\Delta V = \frac{(\text{volume of } d + D) - (\text{volume of } D)}{(\text{volume of } D)}$$

$$= (d + D)^3 - 1$$

$$= 3\frac{d}{D} + 3\left(\frac{d}{D}\right)^2 + \left(\frac{d}{D}\right)^3$$

$$\approx 3\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right]$$

Since ΔV is composed of interstitial voids (between the fine particles) the weight fraction of fines due to the fines film (assuming d and D of equal density) is:

$$W_d = \frac{\delta 3\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right]}{1 + \delta 3\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right]}$$

where δ is the volume fraction solids in a bed of spheres. In cubic packing δ has the value $\pi/6$ or 0.524 and for hexagonal packing $\delta = 0.605$. Trawinski suggests an average of 0.595.

Up to this point the model has considered the particles as being in a fixed bed at rest. In the fluidized state the bed will be expanded and this additional void fraction, unoccupied by solids, must be subtracted from the volume to approximate more nearly the true minimum weight fraction of film fines. The resulting expression is then:

$$W_d = \frac{\delta\left(3\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right] - \frac{\Delta L}{L_o}\right)}{1 + \delta\left(3\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right] - \frac{\Delta L}{L_o}\right)} \quad (1)$$

A reasonable value of $\Delta L/L_o$ is in the neighborhood of 0.25; cracking catalyst exhibits a range of bed density from 39 lbs./cu. ft. at incipient fluidization to 49 lbs./cu. ft. in the densely packed state. With these approximations Equation (1) reduced to:

$$W_d = \frac{1.695\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right] - 0.141}{1.695\left[\frac{d}{D} + \left(\frac{d}{D}\right)^2\right] + 0.859} \quad (2)$$

Relative viscosity of two-component blends of several size fractions as measured by the paddle viscosimeter technique are plotted versus the weight fraction of fines in Figure 6. The minimum fines concentrations as computed from Equation 2 for these three two-component systems is also shown; note that the computed concentration is in fairly good agreement with the observed break point values.

In a manner similar to the technique of Matheson et al, Marks, Broadley and Yellott[3] made a study of the effect of particle size analysis on the angle of repose of mixtures of coal particles. At a constant bed aeration rate of 4 feet per minute, they recorded the angle of repose of several uniform sizes as well as mixtures. Their data was plotted in a manner similar to Figure 6 with angle of repose as the ordinate in place of Stormer viscosity.

Table 1 presents their data for 1/16 inch coal which was the only material varied to an extent permitting crude comparison with Trawinski's theory. Trawinski's equation would indicate that viscosity and/or angle of repose would not be lowered much by addition of more than 20 percent less than 50 mesh, but would increase rapidly as the quantity of finer than 50 mesh material dropped below 20 percent. Unfortunately the data in Table 1 can only lend support to the theory since they bridge this concentration too widely to be considered additional confirmation. These data merely indicate the breakpoint as somewhere between 3 percent and 50 percent.

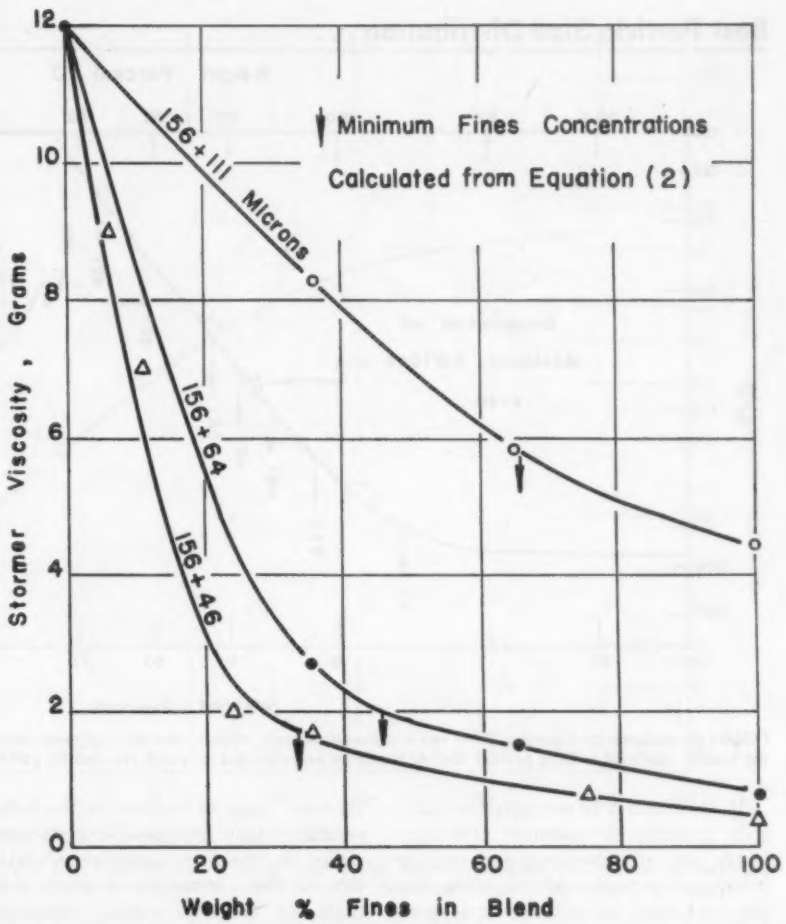


FIGURE 6—Comparison between calculated break-point compositions and two-component viscosity data of Matheson, et al. Notice that the computed concentration is in fairly good agreement with the observed break point values.

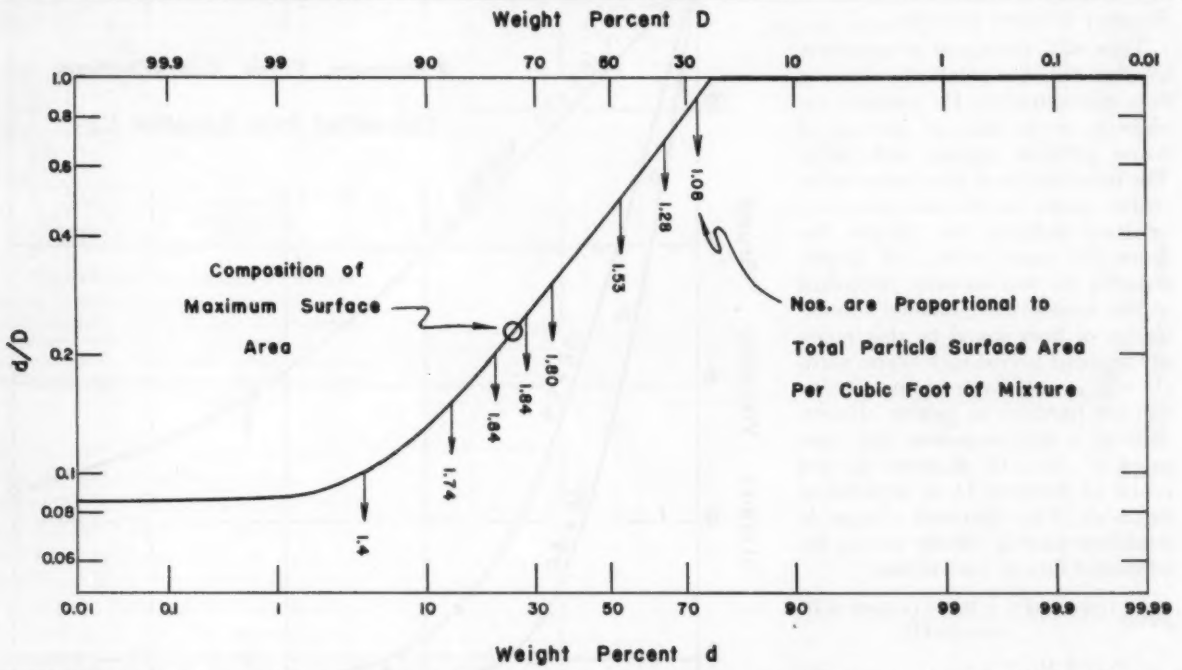


FIGURE 7—Solution to Equation 2 for two-component mixture. Notice that the optimum two-component system is one in which the diameter of the smaller particles is 22½ percent that of the larger particles, and in which the smaller particles constitute 25 percent by weight of the mixture.

If Equation 2 is accepted as valid, it is possible to compute the optimum size distributions for two or more component systems. Consider the fact that in practice it is generally desired to:

1. Maximize bed fluidity or conversely minimize bed viscosity,
2. Minimize entrainment, and
3. Maximize catalyst surface area.

It is of course impossible to completely satisfy all 3 conditions. For example, the greater the fines concentration the more 3 is satisfied but at the expense of 2, etc. However, accepting Equation 2 it is possible to calculate for any two components the minimum quantity of the smaller size necessary to keep bed viscosity at the low value where a greater percentage of fines would not serve to appreciably further reduce the viscosity and would only increase the entrainment rate. Thus Equation 2 defines the composition to satisfy conditions 1 and 2 above, namely minimum viscosity and minimum entrainment, for any two-component system in terms of the ratio d/D.

Assuming the particles to be perfect spheres, the particle surface areas per cubic foot are proportional to the reciprocal of the diameters. This is in accord with the "Carman[2]-Kozeny" type of surface for particles smaller than about 300 microns which is considered more representative of the gas-catalyst contact area than the order of surface obtained by nitrogen adsorption which takes into account the inner pores. The cracking process is essentially thermal rather than truly catalytic in the chemical reaction sense wherein a slow step might involve a radical adsorption or other mechanism. Thus for all values of d/D ranging from 0 to 1.0, the relative total surface areas of the mixture compositions satisfying Equation 2 can be computed.

The results are shown in Figure 7 which indicates that the optimum two-component system is one in which the diameter of the smaller particles is 22½ percent that of the larger particles, and in which the smaller particles constitute 25 percent by weight of the mixture.

TABLE 1
Data of Marks et al for 1/16-Inch Coal

Test No.	Percent Through 50 Mesh	Angle of of Repose at 4 ft./min. Aeration
4201	51.0	5°
5172	3.0	32°
5191	50.5	6°
5201	53.2	5°

In a recently issued patent, Matheson and Hall[5] have discussed the optimum particle distribution for good fluidizing characteristics of relatively coarse particles. They claim that a full distribution from 0 to 500 microns is far less desirable than one ranging from about 100 to 840 microns with 80 percent less than 150 microns and 20 percent in the 590-840 range. They also claim that the ratio of the minimum diameter of the coarse particles to the maximum diameter of the fine particles should be equal to or somewhat greater than four to one. These observations are in good agreement with the results of Figure 7 which gives the calculated optimum composition as 25 percent fines and 75 percent coarse with a diameter ratio of 1/0.225 or 4.5. Note that their optimum blend had an average diameter ratio of $(840 + 590)/(150 \times 2)$ or 4.75.

Multicomponent Systems—Size Distribution. In the application of Equation 2 to two-component systems it was possible to compute any number of compositions of minimum viscosity of which one gave the maximum surface area. In extending the model to multicomponent systems any number of permutations and combinations, in which component

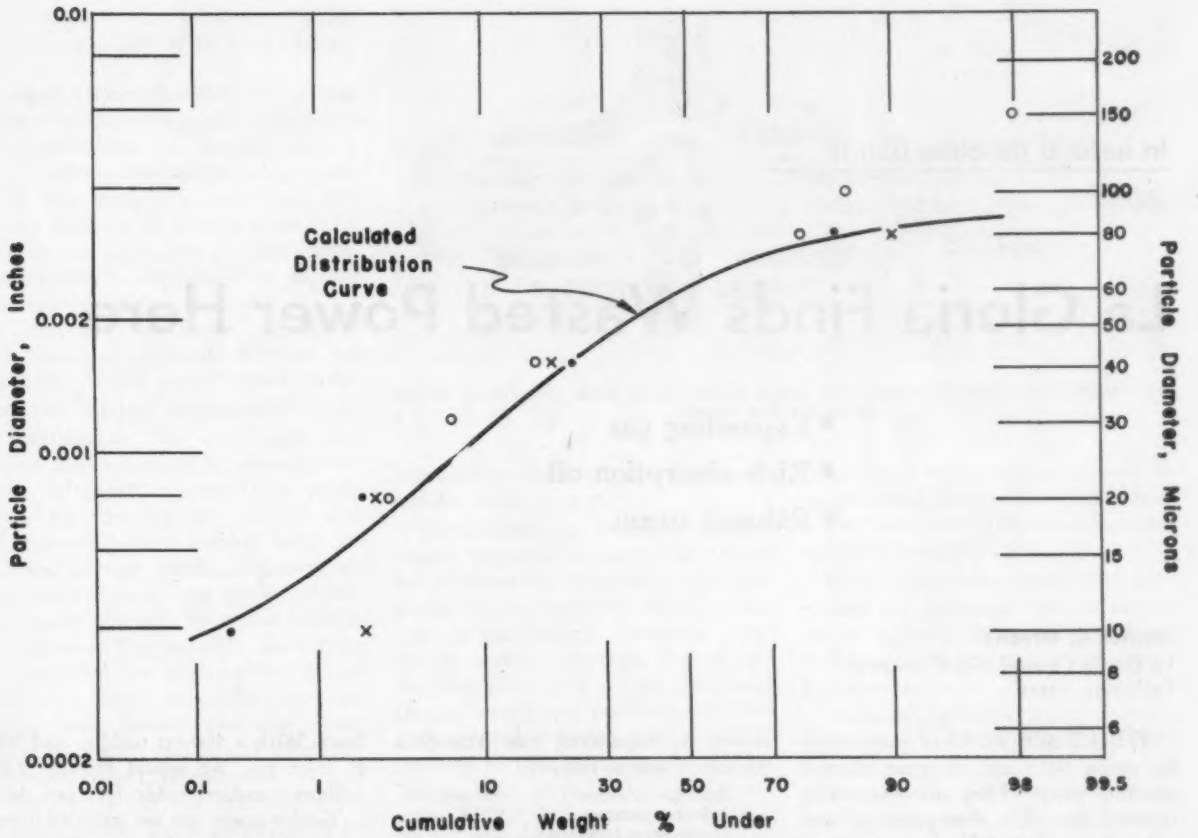


FIGURE 8—Comparison between calculated distribution for multicomponent model and typical catalyst analysis. The relative particle size distribution curve is shown where each component is present in a quantity, relative to the largest component, as defined by Equation 2.

pairs obey Equation 2, are possible. However, it is reasonable to suppose that the optimum distribution would take one or the other of the following two forms:

1. Each component is present in a quantity, relative to the largest component, as defined by Equation 2.

2. Each component is present in a quantity, relative to the next largest component, as defined by Equation 2.

Compositions and cumulative surface areas were computed for a 10-component system having a 10-fold particle size range and conforming to either scheme 1 or 2. It was found that scheme 1 exhibited approximately 10 percent greater total surface area.

Figure 8 shows the relative particle size distribution curve defined by scheme 1 in comparison with reported absolute analyses of a typical fresh microspheroidal cracking catalyst. The approach to asymptotic values of the ordinate at the extremes of the curve is indicative of a minimum and maximum particle size. This deviation from a continuous curve at either extreme is typical of most powders or grinds. These asymptotes are ignored in practice since the percentages become very small at either end of the curve. The log probability coordinates used in Figure 8 are such that a skew-probability distribution would plot as a straight line over the major portion of the abscissa.

Scheme 1 above, which resulted in the greater total surface area, envisions the bed as composed of a series of overlapping two-component systems having the largest particles as a component common to each pair. Thus the entire blend would presumably have a viscosity somewhere between that of a bed consisting of all fines and a bed consisting of only the largest component; the viscosity would approach more nearly that of the fines since they are present in the blend in an amount as prescribed by Equation 2. After being subjected to a fluidizing gas stream for a period of time (assuming no replenishment of the bed losses) the finest particles may be lost from the system; the bed viscosity then falls somewhere between that of the next largest particle size and that of the largest particles etc. The bed viscosity is therefore always nearest that of the smallest particle in the bed since each size smaller than the largest is present in an amount, relative to the largest size, as defined by Equation 2. Accepting this approach to the analysis of fluidity of multicomponent systems the following conclusions can be drawn:

1. The optimum size distribution approaches that of a normal skew-probability distribution and appears as shown by the curve of Figure 8.

2. There is no advantage in exceeding about an elevenfold variation in size between the largest and smallest particle.

Part 3 will appear in an early issue.

LITERATURE CITED

[1] Brown, C. O., Wainwright, R. B., Oil & Gas Journal, 51, No. 30, 133-7, December 1, 1952; Chemical Engineering, 59, No. 11, 148 (1952).
[2] Carman, P. C., Journal Soc. Chem. Ind., 57, 225-34, July (1938).
[3] Marks, C. H., Broadley, P. R., Yellott, paper No. 55-A-118, ASME meeting, Chicago, Illinois, Nov., 1955.
[4] Matheson, G. L., U. S. patent 2,614,069, October, 1952.
[5] Matheson, G. L., Hall, H. J., U. S. patent 2,711,387, June, 1955.
[6] Matheson, G. L., Herbst, W. A., Holt, P. H., Ind. and Eng. Chem. 41, 1099-1104 (1949).
[7] Trawinski, H., Chem. Ing. Tech., 25, 201-3, 229-38 (1953); 23, 416-19 (1951).

In natural gasoline plants . . .

La Gloria Finds Wasted Power Here

- Expanding gas
- Rich absorption oil
- Exhaust steam

Homer C. Givens
La Gloria Oil and Gas Company
Falfurrias, Texas

THREE SOURCES of power may be going to waste in your natural gasoline plant. They are expanding natural gas, rich absorption oil and exhaust steam. La Gloria took a look at its own plant and came up with these ideas for using the wasted power.

1. Expanding Gas. The first source of power that is normally wasted in a natural gasoline plant is the reduction in pressure of flowing natural gas. This power, which is easily converted to useful work, has not been taken advantage of as it should. Any machine manufactured to be powered by steam will work just as well when expanding gas is used.

La Gloria recently asked a steam turbine manufacturing company to give a quotation on a turbine to be driven by expanding gas. The data furnished was as follows:

Inlet gas pressure	300 psig
Inlet temperature	170 F.
Horsepower required	200
Exhaust Pressure	50 psig
Specific gravity	0.6

Quoted price was $5910 for a 4500-rpm turbine and a gas rate of 50.5 pounds per horsepower hour (or 1101 standard cubic feet of gas per horsepower hour). Thus the 200 horsepower turbine would require 5.284 million standard cubic feet of gas per 24-hour day.

Raising the inlet gas temperature to 200 F. would lower the rate to 49 pounds of gas per horsepower hour. If we could use one 400-hp turbine instead of two 200-hp machines, the rate (with inlet gas at 200 F. temperature) would be 45.5 pounds per hour. With a 400-hp turbine and 200 F. inlet gas, we would require 9.47 million standard cubic feet per day.

Twelve years ago we installed a gas engine driven electric generating plant consisting of three gas engines, each driving a 375 KVA alternator. In 1948 we installed a fourth unit identical to the other three. Recently we figured what our electric cost has been over the 12-year period. This figure included the original investment of everything inside the electric generating house, operating expense, using 8 cents per mcf for fuel gas, and all maintenance costs. The result was 0.38 cent per kilowatt hour. We then estimated our electric cost if we had installed two gas engine driven units originally and one turbine driven unit using part of the 12 million cubic feet of fuel gas we were reducing in pressure from 300 psig to 50 psig. For maintenance cost estimate we used figures we had on a large steam turbine installed at the same time as the three electric generating units. This estimate gave 0.2 cent per kilowatt hour. Total saving for the 12-year period would have been in excess of $150,000.

So far, we have been discussing only turbines but expanding gas also is excellent for powering any reciprocating machine built for steam. However, the efficiency is not as good, or in other words, cubic feet of gas per

Expanding Gas in Turbine Would Save Here . . .

Installed: Four gas engines to drive electrical generators
COST per kilowatt hour . . . . . 0.38 cents

Alternate installation: Two gas engines plus one turbine
COST per kilowatt hour . . . . . 0.20 cents

SAVINGS in 12 years by alternate installation . . . $150,000

horsepower hour is greater in a reciprocating machine than in a turbine.

2. Rich Absorption Oil. The second source of power normally wasted is rich absorption oil flowing from a high pressure absorber or a high pressure flash tank to a flash tank at a lower pressure. In a large plant, with 100 million cubic feet per day capacity or more, this power is a very substantial figure.

There are two general classes of machines manufactured to utilize this normally wasted power—the centrifugal and positive displacement units.

Centrifugal. The centrifugal machine, usually termed a hydraulic turbine, is merely a centrifugal pump with oil entering the normal discharge nozzle and leaving from the normal suction nozzle. However, do not expect to use some spare centrifugal pump you may have as a hydraulic turbine. The impeller shaft must be modified by having left hand threads where normally there are right hand threads and vice versa. Also to obtain maximum efficiency the volutes must be modified.

La Gloria has not operated a hydraulic turbine but is preparing to install two 150-hp units during the next few months. Warren Petroleum Corporation and Arcadia Corporation each have one operating and are quite pleased with the results they are obtaining.

The unit Warren is operating drives a centrifugal pump directly connected. The one Arcadia operates drives a septiplex piston pump through a gear box speed reducer.

The efficiency of the entire Arcadia unit is 55.8 percent, considering the power to the hydraulic turbine and the power required to move the oil pumped by the septiplex pump. These multicylinder piston pumps usually have an efficiency of 90 percent; therefore, the efficiency of the hydraulic turbine and gear box speed reducer is 62 percent.

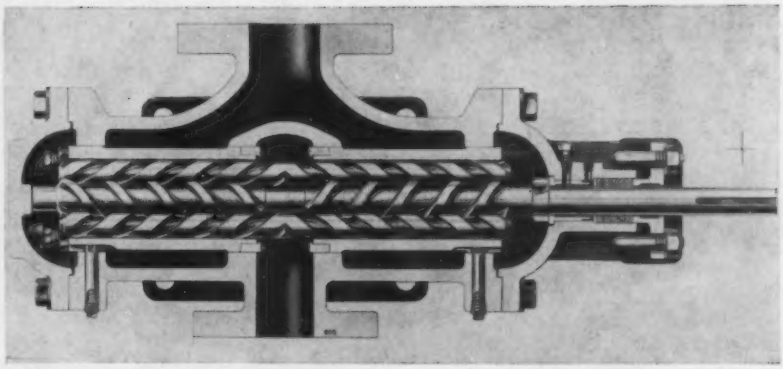


FIGURE 1—Hydraulic motor of the meshing helical screw type: Fluid enters each end and discharges from the middle.

Theoretically, a hydraulic turbine should have the same efficiency as it would operating as a pump; and actually this is true if the fluid in both cases is not flashing. However, a hydraulic turbine operating on rich absorption oil has a higher efficiency than it would as a pump because the governor valve on the inlet oil allows flashing to take place inside the impeller. This gives added thrust because of the flash vapors expanding. This increase has been reported to be as much as 4 percent higher.

Table 1 gives the various costs per horsepower comparison of hydraulic turbines, steam turbines, electric motors, and gas engines for 100 and 250 brake horsepower machines. Appurtenances means the boilers or electric generating plant in their proportionate part. The operating cost of the hydraulic turbine is less than the other three. The maintenance cost of the hydraulic turbine, steam turbine and the electric motor will be almost identical. However, maintenance on the gas engine is much higher.

Positive Displacement. The positive displacement units, usually termed hydraulic motors, are of three types. These three types may be classed as reciprocating piston, meshing helical screws and rotating drum with vanes and timed rotating valves.

The reciprocating piston hydraulic motors are primarily used as meters and to operate intermittently, doing such small jobs as opening and closing gate valves.

The meshing helical screw type is a high speed machine, 3200 to 3600 rmp being optimum. The ones that have given the best service have the fluid entering each end and discharging from the middle. (Figure 1)

La Gloria has had one of this type driving a centrifugal pump continuously since July 1, 1955. It has never been stopped because of anything wrong with it. For a period of six months, a bypass was on the centrifugal pump so it could move its maximum volume, thus requiring the hydraulic motor to develop its maximum horsepower.

During this six months period, records were kept of the rpm, pressure in and out of the motor, volume of oil to the motor, pump suction and discharge pressures and volume pumped. The overall efficiency of the motor-pump unit averaged 41 percent. The pump curves gave an efficiency of 60 percent; therefore, the motor was 68.4 percent efficient. However, this is not a true value of efficiency for the motor, as a one-fourth-inch copper tubing bled oil from the mechanical seal cage to the discharge of the motor. It is believed some 30 to 35 gpm was bypassing the motor through this line.

If we consider 35 gpm was bypassing the motor, the efficiency would be raised to 80 percent. We do not believe the bypass line is necessary

TABLE 1

How Hydraulic Turbine Compares in Cost With Other Drives

UNIT	HP	Purchase Cost per HP	Installed Cost per HP	Appurtenance Cost per HP
Hydraulic Turbine	100	$134.75*	$164.75	$164.75
	250	70.00	90.00	90.00
Electric Motor	100	58.50	89.50	189.50
	250	35.50	61.00	161.00
Steam Turbine	100	36.00	76.00	226.00
	250	30.00	66.00	216.00
Gas Engine	100	75.50	90.00	90.00
	250	115.00	145.00	145.00

* Average cost of several makes and types and includes gear box speed reducer.

La Gloria Finds Wasted Power . . .

but there is no way of shutting it off except by stopping the motor. This particular motor was governed with the inlet oil valve the first two weeks and due to flashing effect in the screws showed several percentage points higher efficiency.

Because of the flashing, it was decided to govern with the outlet valve, not knowing whether vapors would increase the wear on the screws or not. After six months operation the manufacturer completely dismantled the motor and measured all parts for wear. No wear could be detected. It's likely that if a few more horsepower were needed from this unit, governing with upstream valve would not hurt it.

The rotating drum with vanes and timed rotating valves positive displacement hydraulic motor (Figure 2) in our experience is very good when operating at 300 to 800 rpm. It is ideal to drive fans on fan-cooled equipment. If the fan is light weight, it can be mounted directly to the motor shaft. If the fan is too heavy to mount directly on the motor, the motor may be mounted vertically with shaft extension either up or down. V-belts, running in a horizontal plane, can be used to drive the fan.

These motors are very efficient, having been checked when driving a centrifugal water pump as high as 92 percent. Two units we have driving fans on still overhead condensers have an efficiency of 85 percent from oil in to air away from fan.

One of these units that Warren operates is directly connected to a centrifugal pump feeding a deethanizer. It drives the pump at 3400 rpm and has been doing an excellent job for six months at the time of reporting.

Both of the latter hydraulic motors compare favorably in purchase cost and installed cost with a high efficiency steam turbine. They are higher than electric motors in the 15 to 50-hp sizes but closely approach electric motors in the 75 and 100-hp units. However, the cost of obtaining steam or electricity must be taken into account when deciding which driver to use.

Good low cost governors for hydraulic machines have not been developed yet. Therefore, at present most are operated either by hand adjusting the proper valve; or a demand pressure or flow controller. Hydraulic units are especially suited for controlling by demand controllers.

3. Exhaust Steam. Another source of normally wasted power in a large plant is exhaust steam if most pumps are run by steam turbines. It is not economical to run a large number of small steam turbines full condensing; therefore, most of them exhaust at 10 psig. This steam can be collected and used to drive a large horsepower low pressure turbine. La Gloria is planning on using 80,000 pounds per hour of such steam to drive two 1425 horsepower turbines. These machines will be operating by January 1958.

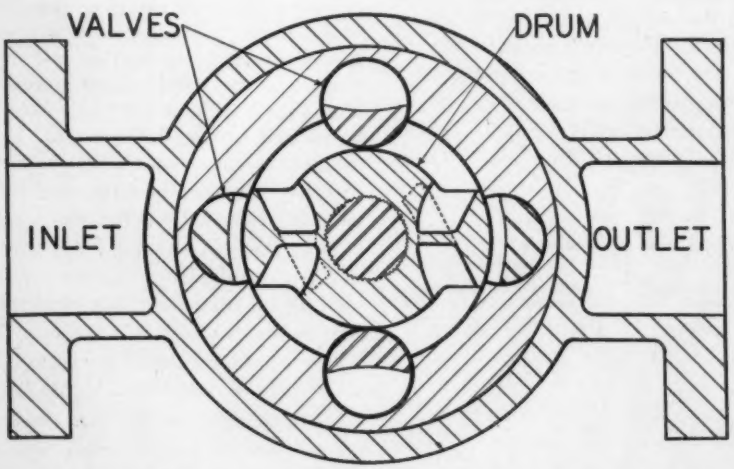


FIGURE 2—Rotating drums with vanes and timed rotating valves in a hydraulic motor: Ideal to drive fans.

About the Author

Givens

HOMER C. GIVENS has spent 26 years in all phases of construction and operation of natural gasoline plants. Now superintendent of La Gloria Oil and Gas Co.'s cycling and natural gasoline plant at Falfurrias, Texas, Givens joined the company as chief operator in 1941. Prior to that he spent almost eight years with Shell Petroleum Corp. in the Natural Gas-Gasoline department, and almost three years in the same department of Gulf Oil Corp. Later, he spent six months with Natural Gasoline Plant Construction Co., and did the engineering and supervised the construction of a natural gasoline plant near Grand Rapids, Mich. Givens received his B.S. degree in mechanical engineering from Oklahoma A & M College in 1929.

This steam was with us 12 years ago when we added the electric generating plant. Great savings would have been realized if we had used it to generate electricity and the expanding fuel gas to power the circulating water pump and fans on the cooling tower for the surface condenser. Probably, it would have been in the neighborhood of a $250,000 saving and several times that in worry for the entire operating force.

Thus, anyone contemplating building a new plant or enlarging an existing one should examine every source of power that normally is going to waste.

Original presentation was before the Natural Gasoline Association of America, Houston, April 24-26, 1957.

ACKNOWLEDGMENT

Author wishes to thank Warren Petroleum Corporation, Arcadia Corporation, Rockwell Manufacturing Company, Ingersoll-Rand Company, DeLaval Steam Turbine Company, Worthington Pump and Machinery Corporation, and Pacific Pumps, Inc., for all data furnished.

US RUBBER PACKINGS

SIMPLIFY YOUR PACKING PROBLEMS

these 6 packings will handle most of your requirements

STYLE 193

STYLE 193—U. S. CENTRIFUGAL PUMP PACKING

For centrifugal pumps, or other rotating or oscillating rods or shafts, handling hot or cold, fresh or salt water, oil, brine, weak acids, caustic solutions and ammonia. Made of long fibre asbestos yarn, plaited square. Each strand thoroughly lubricated and graphited.

STYLE 101—U. S. RAINBESTOS HIGH-PRESSURE ROD AND PLUNGER PACKING

Designed for high-pressure steam, air and gas up to 500° F. Made from selected asbestos cloth, woven from tightly twisted asbestos yarn, with a genuine U. S. Rainbow non-hardening cushion, formed square, and treated with heat-resisting lubricants and preservatives and with a graphite solution.

STYLE 101

STYLE 16010—DUCK AND RUBBER

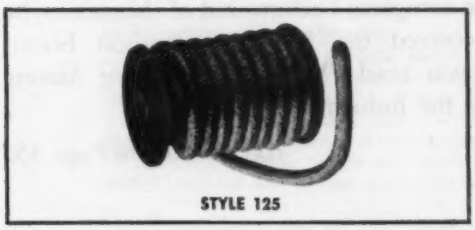
STYLE 16010—U. S. MATCHLESS PACKING

Matchless is the high-pressure packing—will withstand hydraulic pressures as high as 8000 pounds. Self-adjusting, automatic action results in reduced wear and tear on rods and plungers, minimizes friction, keeps down packing costs. For hydraulic equipment, presses, rams, triplex pumps, outside packed pumps, and swivels on rotary drilling rigs.

STYLE 463—U. S. PEERLESS CANVAS PUMP PACKING

For service on inside packed pumps against hot or cold water, and for end rings in hydraulic sets. Made from first quality, closely woven duck laminations cemented together with a high quality rubber friction. Light in weight.

STYLE 463



STYLE 125

STYLE 125—U. S. WIZARD ROUND BRAIDED ASBESTOS PACKING

For use in valve stems, reciprocating rods and plungers, against steam, air, hot and cold water, ammonia, oil, chemicals and some acids. Made of long fibre asbestos yarn, braided in round cross-section in the braid-over-braid construction, thoroughly lubricated and graphited throughout.

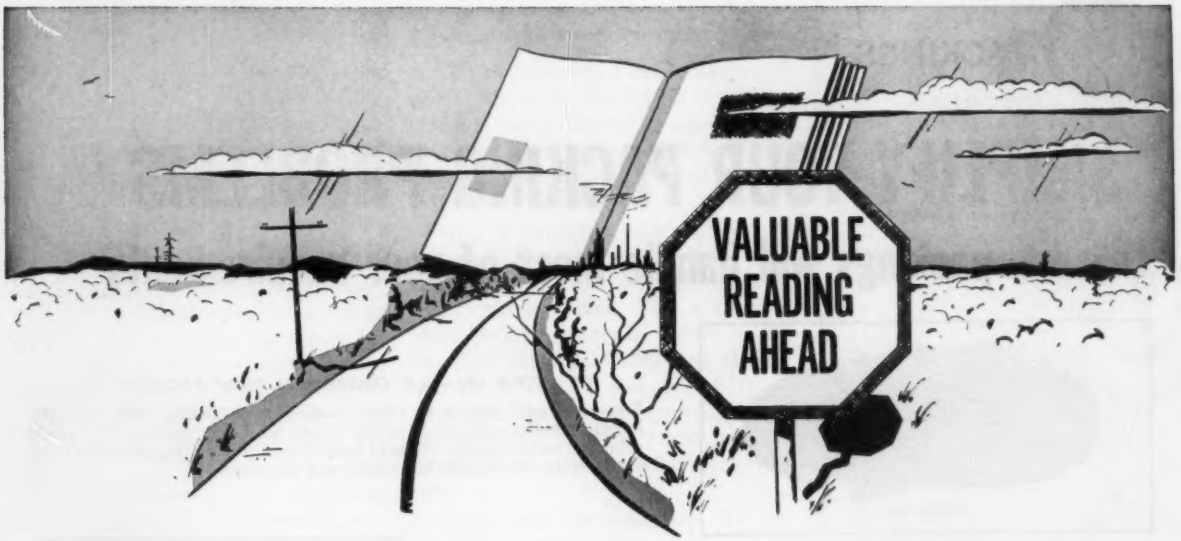
STYLE 899 (F.O.P.)—U. S. COMPRESSED ASBESTOS SHEET

F.O.P. (Fibre Oil-Proof) is the original oil-proof asbestos fibre high-pressure sheet developed especially for oil industry conditions. Recommended for packing flanges or joints against superheated or saturated steam, air, ammonia, gases, oil, gasoline, water, some acids, alkaline solutions and other chemicals. Ideal for Still Head gaskets. It will not soften, burn, blow or ooze out of a joint, and does not deteriorate with age in stock.

STYLE 899 (F.O.P.)

US RUBBER **Mechanical Goods Division**

United States Rubber



Are Your Employes Satisfied?

That's the subject of our first book in this month's "Reviewing New Books." Published by The National Association of Manufacturers, *Satisfying the Salaried Employee* is a practical manual for building better relations with the white collar people. Be sure to read the interesting review to this valuable book.

Keep Going to Page 272

A Terrific Patch-Job

You should have seen the holes in that corroded water header—but you can when you turn to this month's "How To Do It." Then you can also see and read about the splendid results that were obtained from patching 40 feet of water pipe that was badly eroded. It's all there for you to read, so . . .

Keep Going to Page 274

Almost from Scratch

That's how Sohio is rebuilding its Toledo refinery—almost from scratch. The ground breaking ceremonies are already over, construction has commenced, and the complete story is right there for you to read. There's also a simplified flow chart of the new refinery showing all the new units that are going in. Read also about the first privately owned butadiene plant which has just gone on stream—plus dozens and dozens of other construction items. All you have to do is . . .

Keep Going to Page 283

Times Are Changing

They certainly are, and that's why you should read "Changing Times," the fast moving account of those items that made news in the industry last month. It's just what's needed by busy industry men who don't have time for anything but a quick run-down of important happenings. See for yourself.

Keep Going to Page 351

Man Among Men

Sun Oil's Charles E. Webber has just been presented with the Hanlon Award. You'll get the complete background of this man who has received the Industry's highest honor, when you read "What's Happening Among Men in the Industry."

Keep Going to Page 357

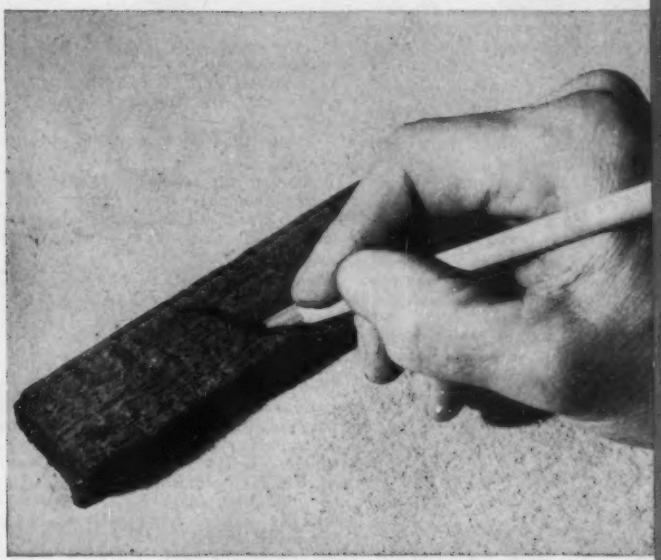
Want to Know More?

Anytime you want a little (or a lot) more information about advertised products or items of new equipment, all you have to do is use the green "Readers' Service Card" enclosed just inside the back cover. If you have never tried it, do so this month. It's put there just for you.

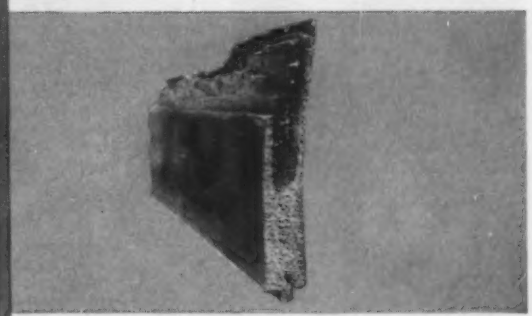
Keep Going to Page 371

Why Cooling Towers Fall Apart

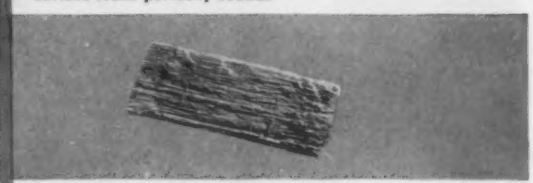
...and how to prevent it!



SURFACE DETERIORATION of cooling tower lumber sample has softened wood so that an ordinary pencil gouges it deeply.



INTERNAL ATTACK by fungus gives no warning of impending collapse. Outer wood surface looks perfectly sound.



CHEMICAL LEACHING from chemicals in water weakens wood, dissolves wood components that resist attack by fungi and bacteria.

Cooling towers often almost literally commit suicide because efficient cooling sets up ideal conditions for deterioration of the best woods used in their construction.

WHAT HAPPENS? Warmth and moisture present in cooling towers are perfect for microbiological growth . . . specifically, the bacteria and fungi which destroy wood. Cooling tower lumber is naturally resistant to these organisms — until the flow of water, containing chemicals either naturally present or added for slime, algae, scale or corrosion control, leaches out the materials which provide this resistance.

Some microbiological growths destroy the cellulose which gives wood its structural strength. Others remove the lignin that is a binder of wood's components. Either way, or both, mean expensive trouble . . . worse if the attacking fungi cause internal decay which can easily go undetected until too late to take protective measures.

PREVENTIVE PROGRAMS

Since cooling towers function with piping and other equipment which must be protected from slime, scale and corrosion, it is evident that measures taken to prevent wood rot and leaching should not interfere with other system treatments — and vice versa.

This is Nalco's cue to enter the picture. The Nalco System takes *all* phases of protection into consideration . . . applies treatments that are compatible with each other . . . and with the cost accounts. A phone call or letter will bring the best efforts of the world's largest water treatment organization to bear on your problems.

★ ★ ★

A magazine article "Why Cooling Towers Decay," goes into detail on the subject. Is available as Nalco Reprint No. 58. Your copy free on request.

NATIONAL ALUMINATE CORPORATION
6259 West 66th Place • Chicago 38, Illinois

CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII and ALASKA:
The Flox Company Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A. SPAIN: Nalco Espanola, S.A.
WEST GERMANY: Deutsche Nalco-Chemie GmbH

THE *nalco*® SYSTEM . . . SERVING WORLD INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

WATER TREATMENT . . . PAPER MILL PROCESS CHEMICALS . . . REFINERY CORROSION CONTROL . . . ION EXCHANGE . . . WEED & BRUSH CONTROL . . . SLIME & ALGAE CONTROL . . . PROCESS ANTIFOAMS & COAGULANTS . . . PETROLEUM CATALYSTS . . . COMBUSTION CATALYSTS . . . FUEL OIL STABILIZATION . . . CHEMICAL INTERMEDIATES . . . CONSULTING SERVICES

For more data on advertised products, use Readers' Service Cards, last page.

Reviewing New Books . . .

"Satisfying the Salaried Employee"

Predicting that white-collar, salaried employees will continue to outnumber blue-collar, wage-earning production workers as the atomic age develops, industrial management is stepping up its efforts to make sure that white-collar morale and job satisfaction are keeping pace with the numerical growth of this group.

The National Association of Manufacturers has just issued this study which describes as a practical manual "for building better relations with all categories of white-collar people." These groups include technical and professional, clerical and stenographic, supervisory and administrative, engineering and scientific, sales and research, and staff personnel.

The study, which is the latest addition to the association's continuing campaign to help management meet the needs of white-collar people, covers four areas which the NAM says hold the answers to job satisfaction in the office and laboratory. They are status and recognition, compensation, communication, and supervision. The booklet sets forth sound practices in each area. It is designed to help employers find out what salaried workers want in their job, and then point up ways and means of providing these job satisfactions.

Because the number of white-collar workers has been increasing steadily (they now total 25.4 million compared with 24.9 million production workers) the NAM appointed about a year and a half ago an advisory group on salaried personnel. The group is headed by Clifford F. Hawker, vice president, Armstrong Cork Company, and includes representatives of du Pont, Eastman Kodak, General Motors, General Electric, Ford, Goodrich and other companies that are leaders in the industrial relations field. This committee has been exploring the whole area of personnel and human relations, communications, and supervisory problems in relation to the salaried worker.

(National Association of Manufacturers, 2 East 48th St., New York 17, N. Y., 53 pages, 50 cents.)

"Natural Gasoline and Cycling Plants in the United States, January 1, 1956"

This biennial survey contains a complete listing by company and location all the natural gasoline and cycling plants in the U. S., as of January 1, 1956. Broken down by states, the list includes the specific product capacity, as well as total capacity of each plant. The type of processing used is also indicated.

The survey shows that capacity has increased 7.5 million gallons per day to 46.4. Number of plants has increased from 535 to 600. Average capacity of plants is now 80,550 gpd, compared with 74,130 two years before. Only change in report from previous reports is the use of capacity in gallons per day instead of barrels per day.

(U. S. Government Printing Office, Washington, D. C., write for Bureau of Mines Information Circular 7790, 11 pages, 15 cents.)

Code of Ethics on Recruiting Policies and Procedures

The American Society for Engineering Education and the Midwest College Placement Association have joined to prepare a new "code of ethics" on Recruiting Practices and Procedures.

Employers should avoid "elaborate entertainment and overselling." There should be no "special payments, gifts, bonuses, or other inducements," nor should there be reward for a third party who may prevail upon a student to accept an employment offer.

On their side, students "should not hoard or collect job offers." When a student accepts an offer he should let other prospective employers know his decision and he should not accept additional interviews. Students invited to visit plants or company headquarters should decline unless "sincerely interested" in working for the company, and their expense sheets for such trips should include only expenses directly concerned.

(American Society for Engineering Education, University of Illinois, Urbana, Ill., single copies 25 cents with discount given for quantity purchases.)

"The Significance of ASTM Tests for Petroleum Products"

This is the third edition of this book which has been prepared for the reader who wishes to acquire a general idea of the significance of the various ASTM Methods of Test under the jurisdiction of Committee D-2 that relate to petroleum products. A brief outline of these methods of test and their relation to the performance characteristics of specific products is also discussed, so that the reader may have some idea of the applications of the various methods. This book covers only the methods of test that apply to petroleum products, including lubricants and crude petroleum. The language has been kept relatively free of technical terms for those who may not be acquainted with such terms.

(American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 115 pages, list price $2.50, ASTM member price $1.85, cloth-bound copies 75 cents additional.)

"Corrosion: A Compilation"

Dr. Mars G. Fontana, chairman of the department of metallurgical engineering at Ohio State University, is the author of this book.

Practically all metals and alloys and some non-metallics used for corrosion applications are covered. The book describes methods and detailed procedures for laboratory and plant testing, and shows corrosion as a function of temperature and concentration of acids through iso-corrosion charts.

Causes and cures for many actual plant problems and mechanisms of corrosion are described in readily understandable terms.

The book is designed as an aid to plant men and as a reference text, or textbook, for courses in corrosion.

(Hollenback Press, Columbus, Ohio.)

"Unfired Pressure Vessel Code Simplified"

By **Robert Chuse**, this book is a simplified analysis of the new 1956 ASME Unfired Pressure Vessel Code. It makes the code easy to use and can save valuable time and material.

The 1957 edition contains simplified charts for internal and external pressure, shell thickness, flanged and dished head thickness, flat head thickness, flat cover plate thickness, and openings and reinforcements. Lengthy problems can be solved quickly and easily with the use of these charts. Also included in the book is a section on Welding Procedure which is a guide to solving welding procedure problems.

Written in an easy to understand manner, this compact book brings you, in condensed form, all the useful information gained in 20 years of approving ASME Code design.

(Robert Chuse, P. O. Box 91, Leonia, N. J., 30 pages, $6.50, single charts $1.00 each.)

Electrical Code RP-500

The second edition of American Petroleum Institute Standard RP-500, "API Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries," includes a specific procedure for evaluating the existence, degree, and extent of a hazardous area in a refinery under the provisions of the National Electrical Code (NEC) and a discussion of the principles on which the procedure is based. The procedure provides a guide for locating electrical equipment so as to minimize fire hazard, but is not a code of regulations and requires sound engineering judgment for its proper application to a specific situation. The NEC grouping of atmospheric mixtures with similar explosive characteristics and the selection of electrical equipment on the basis of flammable atmosphere characteristics are given in an appendix.

(American Petroleum Institute, 50 West 50th Street, New York 20, N. Y., 75 cents.)

"The Procedure Handbook of Arc Welding Design and Practice"

The book is arranged and written as a reference book covering all phases of arc welding. Its contents range from the early history of arc welding to the intricacies of structural design. The eight sections are divided by subject matter for easy study. Each section has its own table of contents, and there is a complete alphabetical index for the entire book. The eight sections are: history, nomenclature and processes, weldability, mild steel procedures, manufacturing cost data, machine design, structural design, applications and reference data.

The weldability section presents information on how to weld all of the commonly welded metals, including such new materials as zirconium and titanium. The mild steel welding procedure section gives detailed welding procedures for all joints. These procedures are said to be lowest cost consistent with good quality and include the new iron powder manual electrodes, as well as new automatic procedures and the latest information on hard-surfacing, carbon arc work, tool and die welding, pipeline, piping and code welding.

(The Lincoln Electric Co., Cleveland, Ohio, 1300 pages, $3.)

3 years on 93% sulphuric acid at Celanese —no leakage from these Crane valves

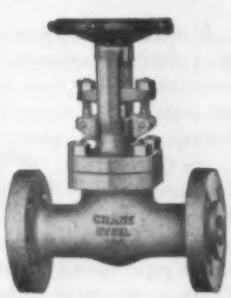
This operator is closing valves with cost records clean as a hound's tooth.

They're Crane 1½-inch No. 3615XW steel gate valves, handling 93% sulphuric acid. Celanese Corporation of America installed them 3 years ago in its large petrochemical plant in Bishop, Texas.

After 3 years on service that's rated severe in any plant's books, these Crane valves are *still* tight, *still* operating easily—and they haven't been opened once for repairs or maintenance.

Unusual? Not with Crane valves. They may look similar to other valves on the outside—but inside, they have the design and materials and construction that can mean the difference between good or poor performance.

That's why so many chemical processing plants *specify* Crane valves. That's why you're always wise to look into the broad Crane line before you buy any valve.



Get the facts from your local Crane Representative, or write to the address below.

CRANE VALVES & FITTINGS

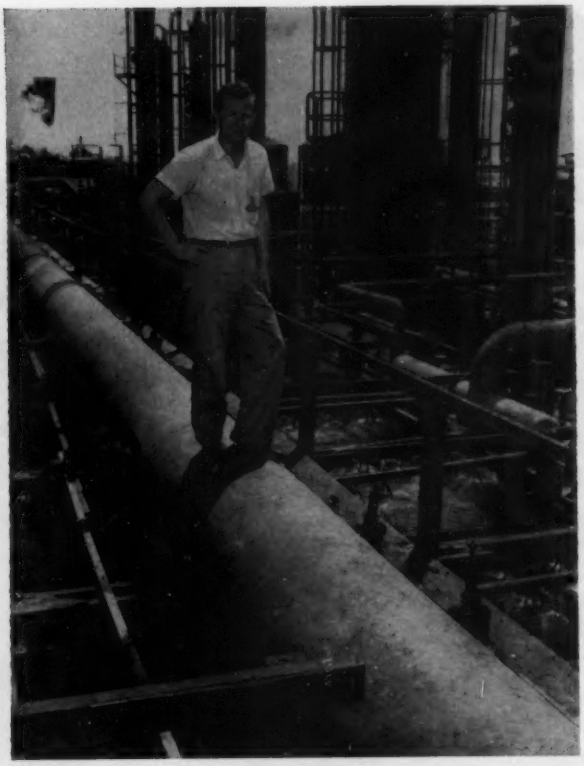
PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .

BEFORE: This water header has sections that have never been maintained and consequently are thin. There is a large hole in the top of the pipe in the section between secondary oxidation and product purification units. The line also has about 20 holes below the water level of the pipe which normally runs half full.



AFTER: Repairs were made with reinforced Celanese polyester resin. Scale was knocked off and two plies of glass cloth, saturated with a self-curing resin blend were applied over the holes. Leaks were plugged and two more plies of glass cloth saturated with resin were wrapped around the rusted areas, one at a time.

Use Resin for Water Header Patch-Job

Here's how Celanese Corp. repaired 40 feet of corroded water pipe with polyester resin.

A recent example of the versatility of Celanese polyester resin in the maintenance of plant equipment was the repair of a water header at the Bishop, Texas, plant of Celanese Corp. of America.

Approximately 40 lineal feet of the header pipe had eroded, with large holes in some areas and the balance of the pipe rusted almost paper thin. There were about 20 holes below the water level of the pipe, which normally runs half full.

The repair procedure used was as simple as it was effective. First, scale was knocked off and two plies of glass cloth, saturated with a self-curing blend of MR-28C Resin, were applied over the large holes. Leaks were then plugged and two additional plies of glass cloth, thoroughly saturated with the resin, were wrapped about the entire rusted area of the pipe, one at a time.

Just 30 gallons of resin were required and total material costs amounted to only $137.88. It was, of course, unnecessary to remove the multiple connections or the pipe itself. Thus, many costly man-hours, that would normally be required if section were replaced, were avoided.

The reinforced Celanese polyester laminate has ample strength to carry the weight of a man standing over the completely rusted-through section of the header. The laminate will not rust or rot and its moisture absorption is less than half of one percent. Experience indicates that long, trouble-free service can be expected. But in the event that accidental rupture occurs, it is only necessary to apply additional laminate to the damaged area. Photographs and story courtesy Celanese Corp. of America.

Look! Here's an Easy Way You Can Stop Valve Leakage

Leakages of oil, steam, or other fluids through the bonnet union of small valves are often experienced in refinery operations. The leakages usually can be stopped by tightening the bonnet union nut, but sometimes

It's NEW! It's Revolutionary!

Ever see a steam trap

SO SMALL

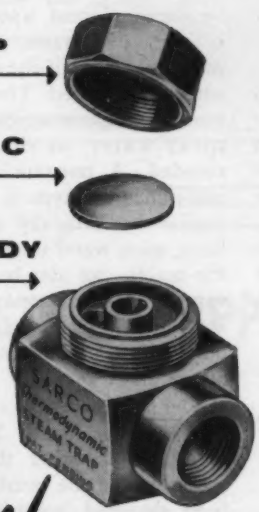
SO SIMPLE

SO TROUBLE-FREE!

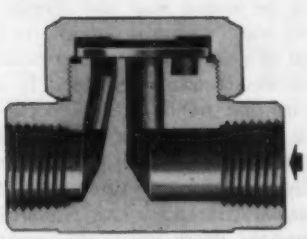
1. A CAP

2. A DISC

3. A BODY



That's all!



YES, SO TROUBLE-FREE: No valve-closing mechanism to wear or stick—the kinetic energy of steam closes valve. No critical clearances to choke. No gaskets to leak.

Practically Eliminates Maintenance!

Here's the *smallest*...the most *compact*...the most *durable* steam trap you've ever seen...for all-around trapping effectiveness! It's the new Sarco Thermodynamic trap.

Look at it. So small...it fits into the hollow of your hand. So simple...only 3 rugged parts...machined from stainless steel bar stock. So trouble-proof...only moving part, a hardened solid stainless steel disc, practically immune to wear. Not affected by superheat, water-hammer, corrosive condensate.

Use the SAME trap for 10-600 psi...for light or heavy loads ...without seat or valve change or other adjustments. Closes tight on no load—no steam waste.

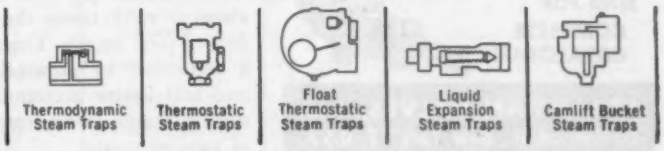
Ask for a 60 day trial installation of Sarco TD trap and strainer...write for bulletin 257. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

2149-B

SARCO

Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.



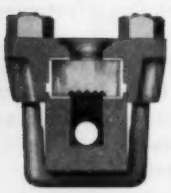
For more data on advertised products, use Readers' Service Cards, last page.

Strahman

HIGH PRESSURE GAUGES

USED IN REFINERIES AND CHEMICAL PLANTS THROUGHOUT THE WORLD

THRU VISION



REFLEX
Single or Multiple Sections

TUBULAR

Gauge Cocks
•
Large Chamber Reflex Gauges
•
Heated or Cooled Gauges

SEND FOR COMPLETE CATALOGUE

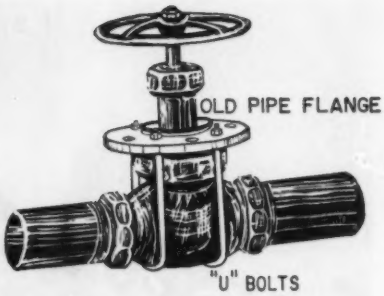
STRAHMAN VALVES, Inc.
16 Hudson St., New York 13, U.S.A.

How to Do It . . .

it takes no effect due to nut or body screw failure.

A piece of abandoned pipe flange from the junk pile and two U-shaped bolts with nuts will help you to keep your unit on-stream if the replacement of the valve should cause the unit shut down.

The flange is placed upon the bonnet union nut of the valve by passing valve stem and bonnet through its center hole, then the U-shaped bolts are put on as shown in the drawing. Now the leak can be stopped by tightening the four small nuts.



Idea Submitted by
Shou Chen Ting
Chinese Petroleum Corp.
Kaohsiung, Taiwan (Formosa)

Make Your Own Steam Desuperheater

A simple desuperheater may be fabricated by using any existing cylindrical welded vessel, provided it is suitable as a pressure vessel for steam. This apparatus should be used only for slight superheat and moderate steam pressures, and where load fluctuations and temperature variations are reasonable.

The general principle of using clean spray-water to eliminate superheat is well-known. By using clean condensate and a small centrifugal pump, this cooled condensate can be used as spray-water for two nozzles, suitably placed in a welded cylinder, as shown in Figure 1.

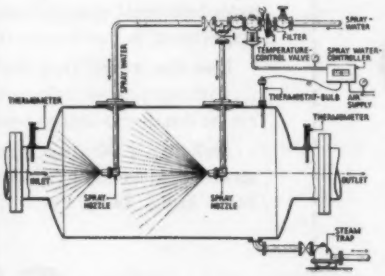


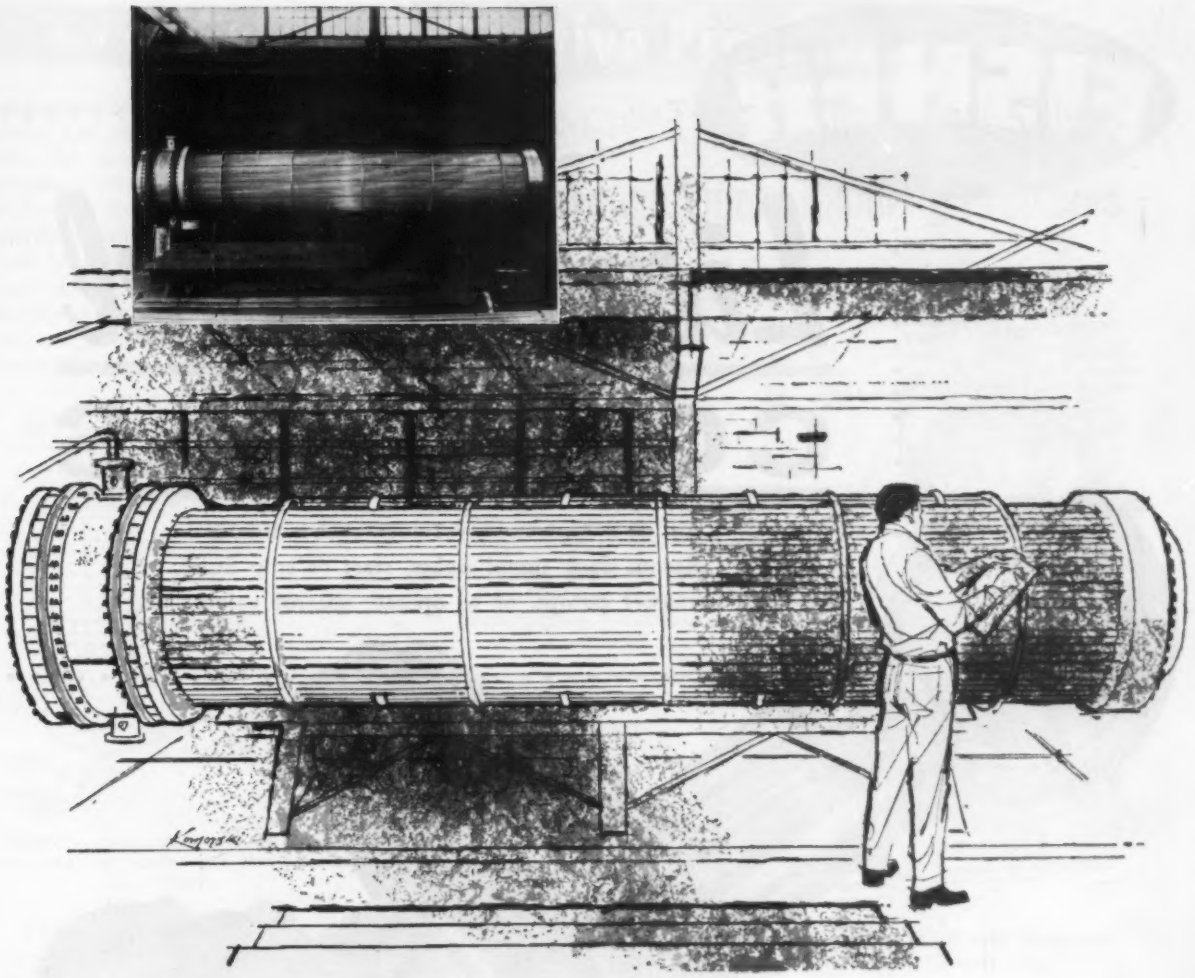
FIGURE 1—General arrangement of a horizontal desuperheater.

The diameter of the cylindrical vessel should be 3 to 4 times the diameter of the steam pipe, and its volume about 5 to 7 times the volume per foot of pipe length. This will produce a reduction of steam-flow velocity, and will insure accumulation of any surplus water away from the stream of passing steam.

Provided reasonable velocity of steam flow is secured, a thorough mixture of the spray-water from the nozzles and of the superheated steam can be expected, and water in the form of mist evaporates, instantaneously and completely, if the spray volume is correctly adjusted. The use of an automatic temperature controller for the spray-water, as shown, is recommended. A pneumatically operated, non-indicating type is shown, but a similar hydraulically operated regulator, using water under pressure from the mains, can also be used with advantage. It is thus possible to obtain any desired dryness fraction of the outgoing steam by simply setting the regulator.

The pressure of the cooling condensate must be 15 to 30 pounds per square inch higher than the steam pressure, and the nozzles should have been designed accordingly. Alternatively, the spray-water can also be taken from the feedwater line of the boiler, using a suitable check valve. It will be noted that the direction of both water sprays is opposite to direction of steam flow, which produces an additional atomizing effect. It is obvious that no heat losses occur with this simple method of desuperheating, because the extracted superheat is fully used for evaporation of the spray-water, and a larger quantity of saturated steam leaves the apparatus, having the same heat content as the smaller entering volume of superheated steam.

With the help of steam tables, an



WESTERN SUPPLY SPECIFIED ALCOA ALUMINUM ALL THE WAY

on these 100% aluminum Dilution Coolers

The exchanger illustrated is one of a number furnished by Western Supply Company, Tulsa, Oklahoma, for a recent low-pressure polyethylene installation. They selected Alcoa® Aluminum for this service because of its protection of product color and stability, good heat transfer properties and corrosion resistance. For the same reasons, aluminum has also found wide use in ammonium nitrate cooling, sour gas treatment and many low temperature processes.

As Western Supply Company sums up the case for Alcoa Aluminum Heat Exchangers: "In our experience Alcoa Aluminum is a sound, low-cost solution to many of the problems encountered in petroleum refining, natural gasoline manufacturing, petrochemical and chemical processing."

If *you* have heat transfer problems affecting tubes or other components of either the channel or shell side, investigate aluminum! Aluminum offers corrosion resistance and good heat transfer properties at minimum cost, and has excellent physical properties at extremely low temperatures. Get details in the FREE BOOKLET, *Alcoa Aluminum Heat Exchanger Tubes*. Mail the coupon today!

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA
905-E Alcoa Building, Pittsburgh 19, Pa.

☐ Send me the FREE BOOKLET, Alcoa Aluminum Heat Exchanger Tubes.

☐ My heat exchanger problem is:

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

FISHER®

Series 2800

Liquid Level CONTROLS

For use as high and low limit switches, to sound alarms, flash signal lights, start or stop fluid transfer pumps, or to operate control valves.

Series 2800

Series 2800 are dependable, inexpensive, snap acting liquid level controls. They are float actuated and, for maximum versatility, are available with either electric (explosion-proof) or pneumatic switch action. Either pilot type is interchangeable on the same float housing assembly. Stab-in type of tank mounting provides easy installation. Available with 4″ iron or steel flanged tank connection. Write for Bulletin F-2800 for complete information.

FISHER GOVERNOR COMPANY
Marshalltown, Iowa • Woodstock, Ontario

estimate of required volume of spray-water, can be easily made. By splitting the spray-water pipe into two sections, certain adjustments can be performed by means of two corresponding hand-control valves, one in each branch pipe, thus insuring that each nozzle works within its range. For low loads, one nozzle can thus be cut, and for medium loads both spray-water pipes can be slightly throttled.

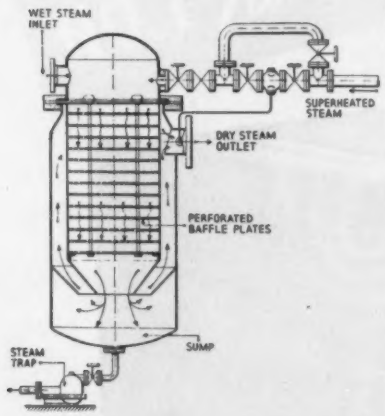


FIGURE 2—Desuperheater layout for mixing saturated wet steam with the superheated supply.

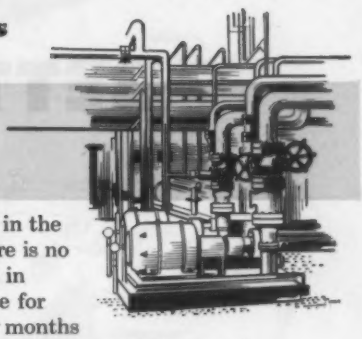
Figure 2 shows a more elaborate type of desuperheater of European design, which reduces high superheat by admixture of saturated or even wet steam. A number of perforated baffle plates produce a thorough mixture of both steam volumes, and direction of the blended steam is suddenly changed by means of a conical reduction in the path of the steam. Any surplus moisture in droplet form is thus extricated and can be drained by a ball-float trap. The lower part of the vessel can be unbolted and lowered for cleaning the baffle plates, which latter can also be lowered and taken out, by means of handles on the rods on which they are suspended.

To reduce pressure drop, the free area of the holes in each baffle plate is three times the pipe area, and the apparatus becomes somewhat voluminous. By automatically controlling admixture of superheated steam by means of an indicating hydraulically operated temperature regulator, any moderate superheat can be achieved on the outlet from the apparatus.

Positive Proof...

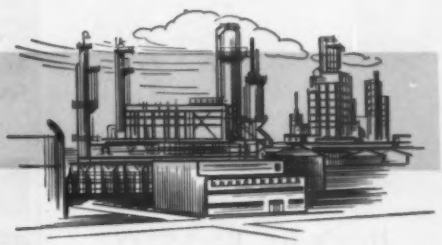
The John Crane® Type 9 Shaft Seal Solves Those Tough Liquid Handling Problems

Actual Field Reports



from an Arkansas Refining Plant

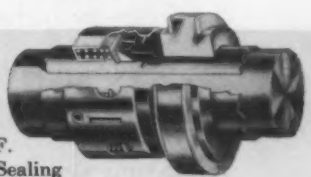
When it comes to avoiding trouble in the handling of naphtha at 420°F., there is no substitute for positive sealing. And in cases like this there is no substitute for "John Crane's" Type 9 Seal. Many months of completely satisfactory operation offers convincing proof.



from a Louisiana Refinery

It takes a "lot of shaft seal" to handle a highly corrosive mixture such as an emulsion of sulphuric acid and butane. This stuff plays real havoc with metals due to its corrosive action. Despite this, Type 9 Seals on twenty seven pumps are pumping month after month in continuous service. At this same location, other Type 9's are effectively handling "fresh" sulphuric acid at the high suction pressure of 400 psi.

In cases like these . . . and in those confronting you . . . the surest answer is the "John Crane" Type 9 Seal.



CONDENSED SPECIFICATIONS

Recommended services: all industrial chemicals, corrosives, liquids or gases. Temperatures: −120°F. to +500°F. Pressures: up to 750 psi. Construction: Sealing members of chemically inert DuPont Teflon, metallurgy best suited to service requirements.

Send us your problems. Request Bulletin S-205-2.

Crane Packing Company, 6420 Oakton Street, Morton Grove, Illinois, (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

John Crane — MECHANICAL PACKINGS — SHAFT SEALS — TEFLON PRODUCTS — LAPPING MACHINES — THREAD COMPOUNDS

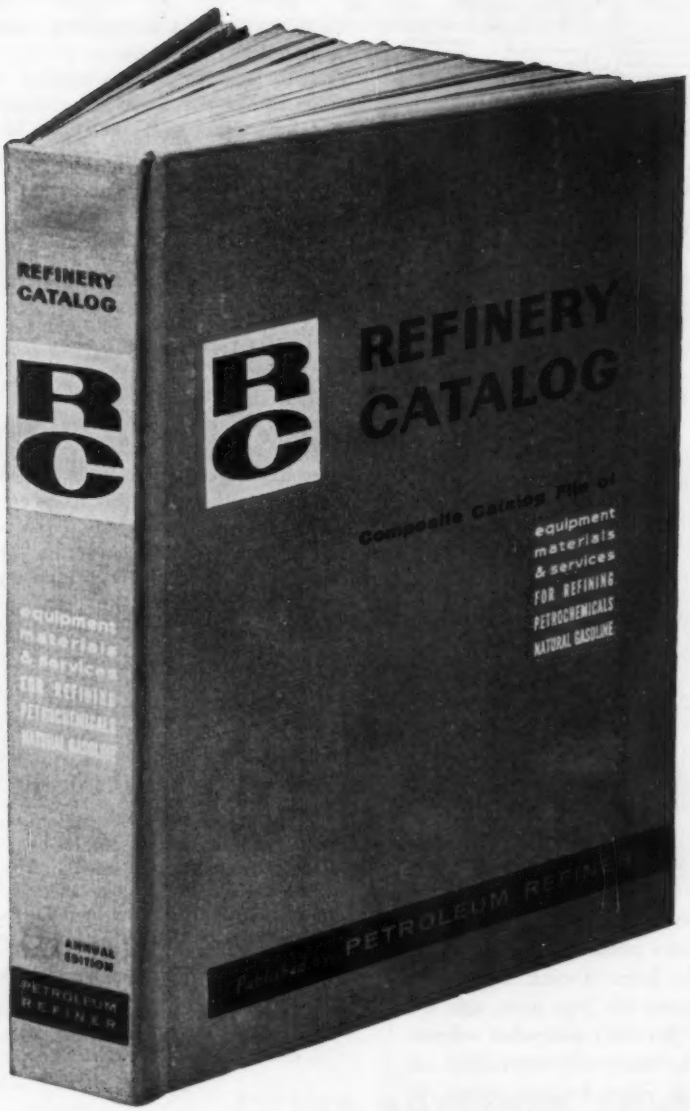
CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

NOW

BETTER THAN EVER

Here's the REFINERY CATALOG's 1957 Edition, better, more complete than ever before.



For more data on advertised products, use Readers' Service Cards, last page.

When you have to make fast, accurate buying or specifying decisions, use the REFINERY CATALOG. It is the Refining Industry's universal equipment guide . . . containing the information you need for adequate comparison on hundreds of different types of products and services.

In the new (24th) Edition, you'll find catalog data from almost 300 companies serving this industry, authoritative specifications and data, local sources of supply . . . and a convenient index of manufacturers, equipment and services.

Remember—*it's the industry's most complete single source of equipment and service data.* Use it to help you on your job.

The REFINERY CATALOG

Published annually by PETROLEUM REFINER, Gulf Publishing Company

P. O. BOX 2608 • HOUSTON, TEXAS, U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

If OIL is Your Business...

You Need NORRIS QUALITY FITTINGS

WELDING REDUCERS AND CAPS

•

REFINERY ALLOY SWAGES AND PLUGS

•

CASING AND TUBING NIPPLES

•

COUPLINGS

Your SUPPLY STORE IS OUR DISTRIBUTOR

W. C. NORRIS, MANUFACTURER

DIVISION OF DOVER CORPORATION

TULSA, OKLAHOMA

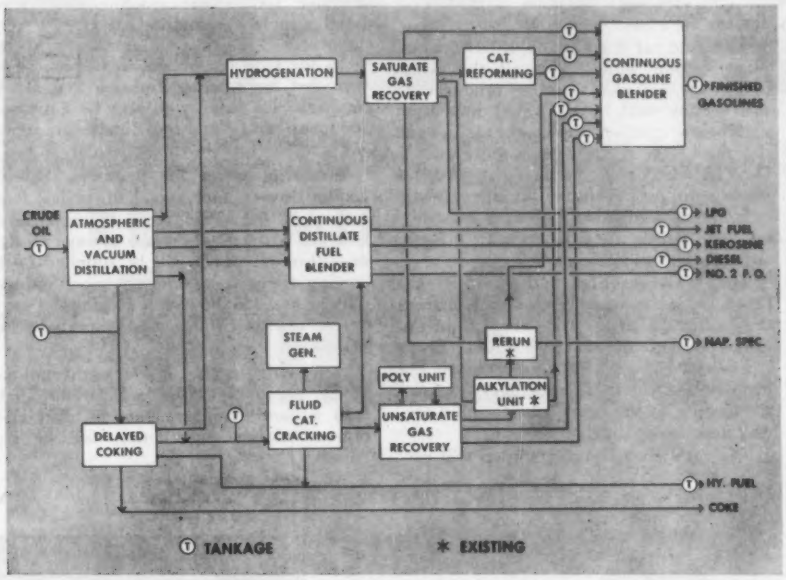
BRANCHES:

GREAT BEND, KANSAS; CORPUS CHRISTI, HOUSTON, KILGORE, ODESSA, WICHITA FALLS, TEXAS;

Since NORRIS 1882

OKLAHOMA CITY, OKLAHOMA
SALEM, ILLINOIS; CASPER, WYOMING;

Who's Building . . .



Sohio Toledo Refinery Simplified Flow Chart

Sohio Rebuilding Almost from Scratch

Toledo refinery "mothballing" all but three units as company slates whopping 31,000-bpd increase.

Following a short groundbreaking ceremony, construction was started on the new $40 million refinery facilities at the Toledo refinery of The Standard Oil Co. (Ohio). The M. W. Kellogg Co., which holds the prime contract of $34 million has slated April 15, 1958 for completion of the new facilities.

When the new units go on stream, the Sohio Toledo refinery will have a capacity of 60,000 bpd, a net gain of 31,000 barrels over present facilities. With the exception of the present two alkylation units and the rerun unit, all other units will be "mothballed" when the new facilities go into production next year.

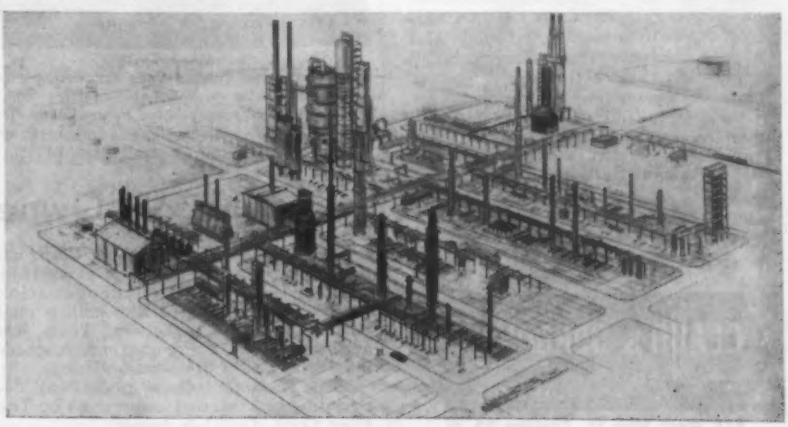
Sohio's new project will combine in one area and in one integrated facility these processes: Atmospheric and vacuum crude oil distillation, delayed coking, catalytic cracking, hydrogenation, catalytic polymerization, catalytic reforming, gasoline recovery and stabilization, treating and continuous gasoline blending and steam generation.

Products of the new Standard Oil Co. (Ohio) Toledo refinery will include liquid petroleum gas, solvent naphthas, automotive and aviation gasolines, jet fuel, kerosine, furnace oil, diesel fuel, heavy fuel oil and petroleum coke.

The crude treating and refining facilities will have a crude charge rate of 60,000 bpd.

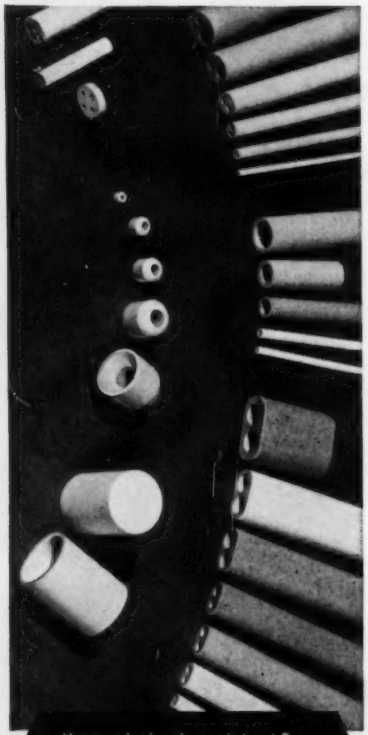
Most of the fractions from this section will receive further processing in the unit. However, some of the lighter fractions subsequent to treating are made directly into salable products such as kerosine, jet and diesel fuels.

The delayed coker section will proc-



The rebuilt refinery will cover more than 20 acres when construction is complete next year.

Insulators for Thermocouples



thermal shock resistant?
mechanical strength?
high temperature resistant?

It's SERV-RITE® for any need

One or more of these SERV-RITE thermocouple insulators will take care of your needs. If not, there are many more in Gordon's large stock for quick delivery. If you need something entirely special, it can be made to suit your specific requirements.

In the 50 years that Gordon has been supplying thermocouples and accessories to industry, emphasis has been on uniform top quality, service, and value. And so with insulators for any thermocouple application, SERV-RITE assures you of plus values every time.

Write for full information on SERV-RITE thermocouple insulators.

Ask for Bulletin 300-56

This new 4-page bulletin gives specifications and ordering data on all Gordon standard SERV-RITE thermocouple insulators grouped for easy selection. 6404

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

615 West 30th St., Chicago 16, Ill.
2019 Hamilton Ave., Cleveland 14, Ohio

Who's Building. . .

ess the residual heavy oil from the crude-vacuum section, to produce naphtha, cat cracker feed stock and coke.

The fluid cat cracker and unsaturate gas plant section will process all the virgin and coker gas oils. Gasoline produced in this section will be separated into light and heavy catalytic distillate to increase the flexibility of the final gasoline blending. The cat cracker will also produce a propane-propylene stream for the catalytic polymerization section feed and a butane-butylene stream for alkylation in the two two existing alkylation units.

The hydrogenation and saturate gas plant section is capable of hydrogenating the gasoline boiling range stocks from the crude-vacuum and coker sections. These stocks will be separated into light naphtha for gasoline blending and heavy naphtha for feeding to the catalytic reforming section and the existing rerun unit.

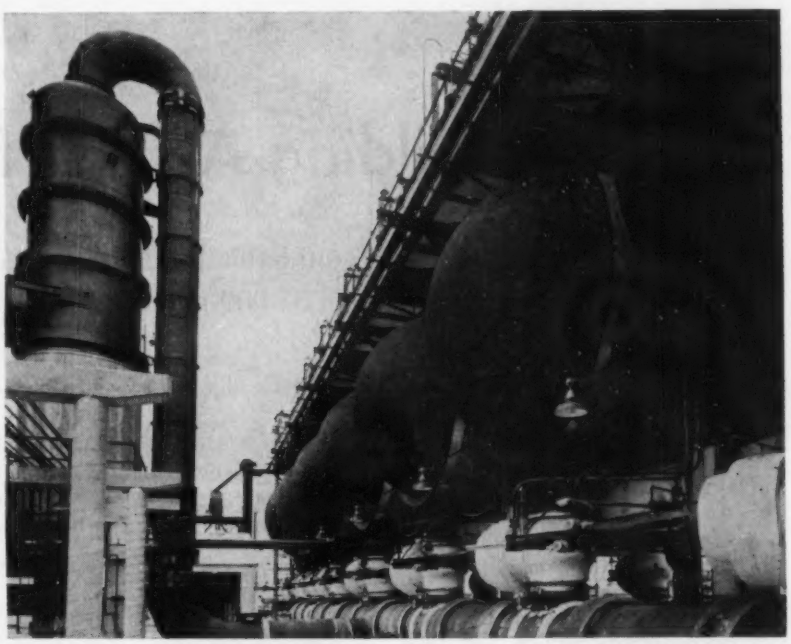
The catalytic reforming section will catalytically reform 12,000 bpd of hydrogenated heavy naphtha. This section will be a fixed bed facility equipped for on-stream regeneration of the platinum catalyst.

The catalytic polymerization section will produce 100 octane gasoline using propane-propylene from the cat cracker section.

In the treating section, facilities will be provided for treating kerosine and heavy naphtha. Facilities will also be provided for spent caustic and foul condensate treating and for furnace oil drying.

Industrial water for process cooling, cooling tower make-up and boiler feed water will be taken from Maumee Bay. Cooling water requirements not met by the once-through water will be supplied by a cooling tower re-circulating water system. City water will be used for sanitary purposes and for emergency boiler feed make-up.

New crude and operational tankage, totaling 352,000 barrels, will be installed. Also a considerable amount of road and railroad siding construction will be required.



Each of the two Houdry Dehydrogenation process units at Texas Butadiene & Chemical Corp.'s new plant has seven horizontal reactors. For the first time in a cyclically controlled plant, the valves (bottom) are operated hydraulically. The second of the units is scheduled to go on stream shortly. The $30 million plant was engineered and constructed near Houston by The Fluor Corp., Ltd.

First Privately Owned Butadiene Plant

Texas Butadiene & Chemical Corp. has brought on stream the first of two 43,000 tons-per-year Houdry Dehydrogenation process units at its new $30 million dual purpose plant at Channelview, Texas, just outside Houston. The second unit is scheduled to be placed in operation shortly.

The Texas Butadiene plant was designed, engineered and constructed by The Fluor Corp., Ltd., Los Angeles.

When both units are on stream, the plant will produce 61,000 tons of butadiene annually and roughly 2.5 million barrels of aviation grade alkylate or, alternatively, 86,000 tons per year of butadiene.

This is the first new butadiene plant to be completed by private industry since World War II, and it is the third such plant to use the Houdry Dehydrogenation process.

Of the other two units, which were built

STOP!

SULFIDE-SCALE FORMATION IN REFORMING UNITS!

with Alumi-Spra*

This PROVEN aluminum coating *not affected by* H_2-H_2S in furnace tubes and feed lines.

SULFIDE-SCALE formation in reforming units has been a king-size headache for oil refineries. In some cases, it has been necessary to chemically clean tubes and transfer lines every few months. This is costly. It hikes maintenance costs, replacement costs, and most importantly, *cuts production, thus depriving oil companies of valuable income!* No wonder everyone is trying to prolong the effective life of these vital tubes.

Here at last is a proven answer to the problem. Chicago Metallizing Corporation's new ALUMI-SPRA is a positive way to prevent corrosion due to sulfide scale. The new ALUMI-SPRA process actually makes an aluminum-clad tube out of your standard furnace or feed line tubing. Aluminum is deposited uniformly and with a firm bond to prevent any tendency toward spot breaks in the coating which would allow corrosion to form locally and spread. Thus, on-line service duration is increased two- or three-fold over that of ordinary steel tubing, without the formation of sulfide scale. Thus, good heat transfer is maintained, allowing furnaces to be operated at normal design temperatures.

And the cost of ALUMI-SPRA is reasonable too. This, plus the fact that down-time is cut in half, makes ALUMI-SPRA the most reasonable kind of corrosion protection you can get. Write or call us today for further details and study of your particular problems.

SEND FOR COMPLETE FACT FILE—We can furnish complete literature and specifications to enable you to consider ALUMI-SPRA in light of your particular situation. For your fact file, write Chicago Metallizing Co., 3321 South Pulaski Road, Chicago 23, Illinois. Do it today!

Alumi-Spra*

CHICAGO METALLIZING CORPORATION
3321 South Pulaski Rd. • Chicago 23, Illinois
Phone Virginia 7-7535

*U.S. Patent Applied For

For more data on advertised products, use Readers' Service Cards, last page.

BETZ LABORATORIES

REGISTERED PROFESSIONAL CHEMICAL ENGINEERS

W. H. & L. D. BETZ

Chemical Engineers

CONSULTANTS ON ALL WATER PROBLEMS

GENERAL OFFICES AND LABORATORIES
GILLINGHAM AND WORTH STREETS
PHILADELPHIA 24, PENNSYLVANIA

is now

BETZ

BETZ LABORATORIES, INC.

GENERAL OFFICES | ENGINEERING HEADQUARTERS
GILLINGHAM & WORTH STREETS, PHILADELPHIA 24, PA.

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

for wartime use, one has been dismantled and the other is still in operation at the El Segundo refinery of Standard Oil Co. of California. The new Texas Butadiene & Chemical Corp. unit now in operation was the first domestic unit to be licensed by Houdry since the war and is the first to be completed.

For the first time in a plant of this type, axial flow compressors have been used for hydrocarbon compression. The new plant has nine gas and air compressors, ranging in size from 2500 h.p. to 10,000 h.p.

Also, for the first time in a major process plant, a central hydraulic power system actuates the cyclically operated reactor valves. Fluor believes that this permits quicker operation and more positive movement than other methods.

A steam generator plant provides high-pressure, super-heated steam to the plant at the rate of one million pounds per hour.

The Houdry Dehydrogenation Process is a single-step method, employing an alumina-chrome oxide catalyst, which transforms fresh butane (mixed with butane-butene recycle stock from the butadiene recovery section) into butadiene or butenes. The butadiene recovery section employs the Furfural Extractive Distillation process licensed by Phillips Petroleum Co.

Mixed feed is heated before entering the catalyst chamber. The dehydrogenated effluent gases are compressed, passed through an absorber-stripper unit and fed to the butadiene recovery section. Furfural is the agent which selectively extracts the butadiene as it flows through this section.

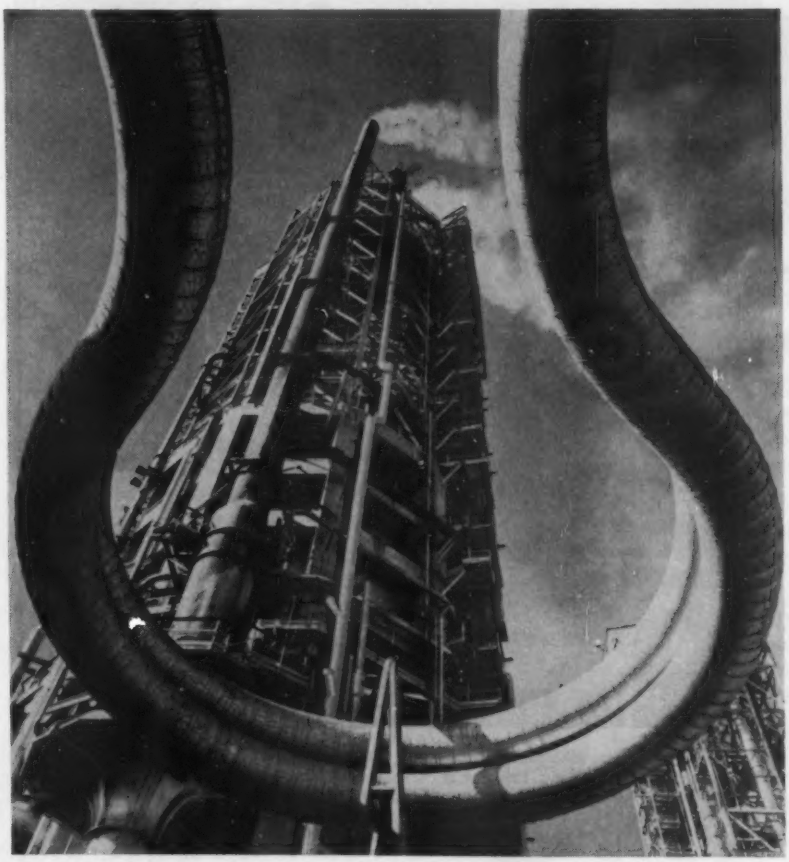
The Texas Butadiene plant's sulfuric acid alkylation unit uses a process licensed by Texaco Development Corp., New York, and an effluent refrigeration system licensed by Stratford Engineering Corp., Kansas City, Mo.

Who's Building...

Mobil Oil A. G. has completed a 4100-bpd Sovaformer and a 5500-bpd catalytic hydrogenation unit at its Bremen, West Germany refinery. The company is increasing the capacity of the plant from 17,400-bpd to 25,000 barrels daily.

Cal-Mex Oil & Refining Co. has announced new developments in plans for construction of a new $28 million refinery for San Diego. According to George Kessler of Cal-Mex Oil and Refining, the position of Vereinigte Petroleum Werke has been released to permit Cal-Mex to work toward an arrangement with a major American oil company for participation in the venture.

Kessler also reports that a site has been chosen which meets with the approval of San Diego area agencies involved with the



King Size Cracker

The world's largest Thermofor cat cracker has gone on stream for Magnolia Petroleum Co. at its Beaumont, Texas, refinery. The 330-foot tall unit is designed for 28,000 bpd.

Practical know-how for modern plant design

PROJECT ENGINEERING OF PROCESS PLANTS

By HOWARD F. RASE, University of Texas; and M. H. BARROW, Foster Wheeler Corp.

The first book on plant design written from the viewpoint of the project engineer. Brings together a vast amount of information on many phases of engineering, procurement practices, and office management, plus basic chemical engineering principles.

This practical guide shows you how major companies today plan, organize, and execute projects. All phases are covered—the steps and methods of modern plant design, business and legal phases of the project, principles of equipment design and selection, *and* actual construction operations. Note these features:

- **Chapters follow usual steps in plant design.**
- **Excellent drawings illustrate equipment.**
- **Only tested methods used in industry are presented.**
- **Design equations are developed so that their limitations will be understood.**
- **Examples of actual design calculations, specifications, and contracts are used wherever possible.**
- **Economics is discussed in relation to each phase of plant design and procurement.**

Just Out. 692 pages. 195 illus. $14.25

Send for a 10-day ON-APPROVAL copy NOW!

JOHN WILEY & SONS, Inc. PR-57
440 Fourth Ave., New York 16, N. Y.

Please send me a copy of PROJECT ENGINEERING OF PROCESS PLANTS to read and examine ON APPROVAL. Within 10 days I will return the book and owe nothing or I will remit $14.25, plus postage.

Name_____

Address_____

City_____ Zone____ State_____

( ) SAVE POSTAGE! Check here if you ENCLOSE payment, in which case we will pay the postage. Same return privilege, of course.

No gauge glass shutdowns for you

A broken gauge glass could seriously affect a plant's operation.

But it's improbable that it will ever happen to you because your distributor carries CORNING®, PYREX®, and MACBETH® gauge glasses.

Your distributor is a forward-looking businessman who's going to make sure that you get gauge glass service when you need it. You can depend on him.

The glasses he sends you will be naturally longer lived. They fit better, they stand up better to temperature changes, to corrosive effects, to just about every hazard they'd be exposed to.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	*Recommended Product*
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Heavy-duty service	MACBETH brand flat gauge glasses
Viewing inside furnaces, reactors, pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York

Corning means research in Glass

Who's Building . . .

selection of a location. A study of prevailing winds assures that the refinery can not cause air pollution in populated areas. Options on the land are presently being obtained.

Also, rapid progress is being made to assure an adequate water supply, and Kessler is confident that this is no longer a serious obstacle. He also said that design and engineering work is proceeding satisfactorily.

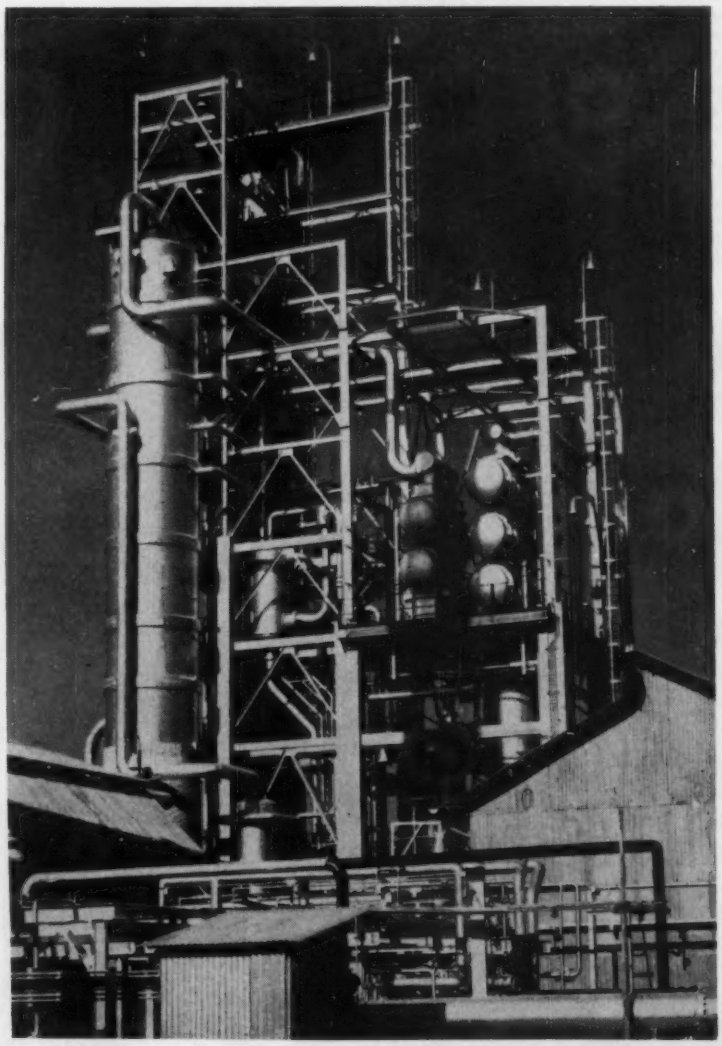
Southwestern Engineering Co., Los Angeles, has been awarded a $1.25 million contract for the construction of new facilities at the Phillipsburg, Kan., refinery of Cooperative Refinery Association.

The new installation will include a 2500-bpd Platformer and a 3500-bpd Unifiner, both licensed by Universal Oil Products Co.

The Phillipsburg project is the second contract Cooperative Refinery has awarded to Southwestern. In June, 1956, the Los Angeles firm completed a Unifiner-Platformer at Cooperative's refinery at Coffeyville, Kan.

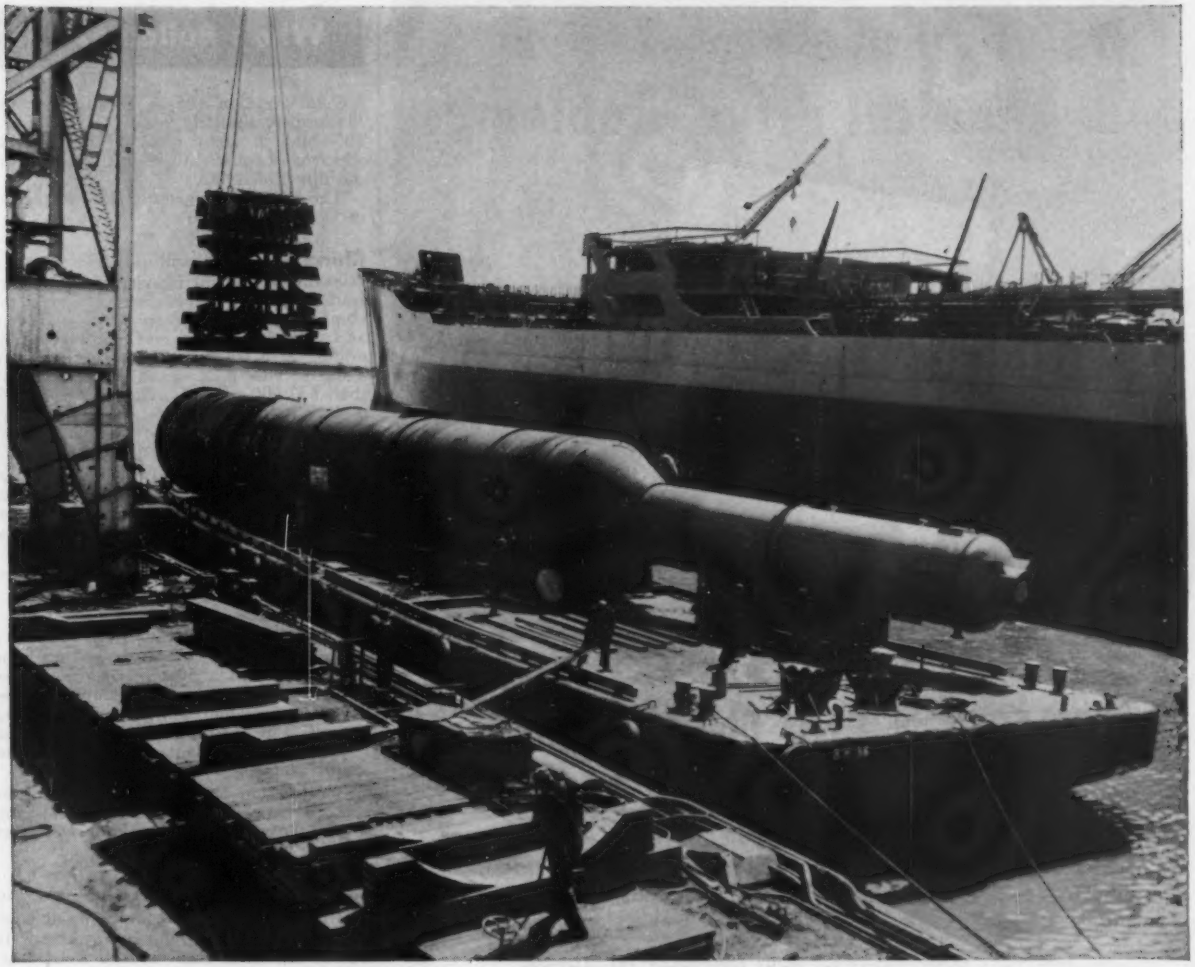
The Unifiner, in addition to desulfuriz-

Burmah Unit On Stream



Shown is the crude oil distillation unit of the new 3500 b.p.d. refinery of The Burmah Oil Co., Ltd., at Syrian, near Rangoon. The plant was opened by the Deputy Prime Minister of Burma in March. Standing in the center of the site occupied by the pre-war BOC refinery (which was heavily damaged at the outbreak of World War II in the East) the new refinery will, with the existing BOC refinery at Chauk in the central Burma oil fields, make Burma self-sufficient in major petroleum products. Crude oil for the new Syrian plant is brought down the Irrawaddy River from the oil fields by barge trains.

For more data on advertised products, use Readers' Service Cards, last page.



standard procedure: VERSATILITY . . .

The variety of work which Sun Ship's integrated shops produce for use by industries on land and sea brings a matching variety of shipping problems.

Our facilities for tidewater shipment are used to economical advantage on many of the massive structures that go into the making of the nation's petroleum and chemical industries. The barge shipment of tower and shed row baffles, shown above, is a good example.

And of course—when shipment by land is necessary—Sun Ship rigging and routing find the ways and means to handle such items as large-diameter columns by rail and truck.

It's all a part of the versatility which forty years' experience has made part of "standard procedure" in service of its customers.

Our Sales Engineering Department would be glad to use its experience in helping you overcome any problem of construction or shipment that faces you. Write

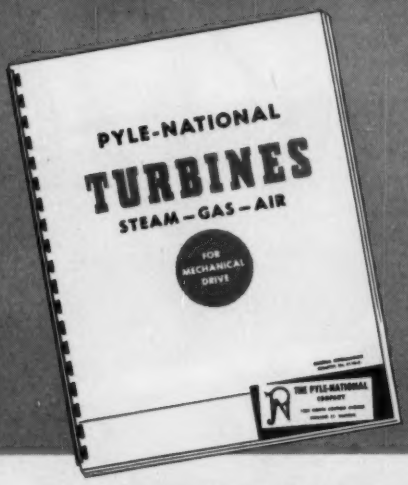
Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 CHESTER, PA.

For more data on advertised products, use Readers' Service Cards, last page.

Do you have a mechanical drive problem?



TURBINE SELECTION AND ENGINEERING DATA BOOK

The most complete reference available to answer your questions on turbines . . . at-a-glance information on speeds, B.H.P., pounds-steam/B.H.P.-hour at various steam pressures.

Request your copy today on your company letterhead.

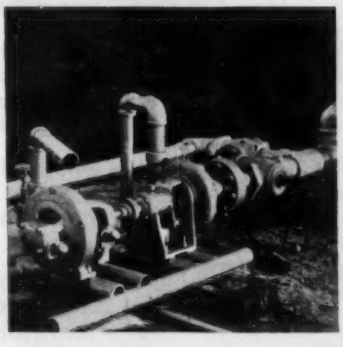
59 years' experience in turbine development

PYLE-NATIONAL TURBINES

¼ to 120 HP for mechanical drive

—the turbines that ask no favors in the refinery or in the field

- Weatherproof!
- Rugged!
- Trustworthy!
- Easiest of all turbines to service and maintain!



Also available: Turbo-Generators (½ to 15 KW)
Turbo-Alternators (60 cycle 3.75 to 25 KVA)

SINCE 1897

THE PYLE-NATIONAL COMPANY
WHERE QUALITY IS TRADITIONAL
1393 N. Kostner Avenue, Chicago 51, Illinois

Branch Offices and Agents in Principal Cities of the U.S. and Canada • Canadian Agent: The Holden Co., Ltd., Montreal • Railroad Export Department: International Railway Supply Co., 30 Church St., New York 7, N.Y. • Industrial Export Department: Rocke International Corp., 13 E. 40th St., New York 16, N.Y.
CIRCUIT CONTROLS • PLUGS AND RECEPTACLES • LIGHTING FIXTURES • FLOODLIGHTS

Who's Building . . .

ing 2500-bpd of charge naphtha for the Platformer, similarly treats an additional 1000-bpd of light straight run gasoline which is of sufficiently high octane to permit direct blending.

The project is scheduled for completion in December, 1957.

China reportedly will disperse its refineries throughout the interior of the country from their present concentration on the coast. The largest refinery which is located at Lanchow, already serves the biggest operating field which is in the northwest at Yumen. This field which produced more than 637,000 tons of crude last year (this is over half of China's total production) is expected to produce 800,000 tons this year.

Other refineries will be built in Chinghai (near Tibet) to serve the Tasidam basin and in Sinkiang to serve the Karamai field which is estimated to contain about 100,000 tons.

Total consumption in China remains only around two million tons annually.

Carbide Industries, Ltd., subsidiary of British Oxygen, Ltd., has arranged for the purchase of a 50-acre site near Londonberry, Northern Ireland, for a plant to produce acetylene. The tract adjoins Du Pont (U. K.) Ltd.'s, proposed neoprene synthetic rubber plant. Carbide plans to supply acetylene to Du Pont.

Construction on the Carbide Industries plant is expected to commence sometime within the next year. Du Pont will start building around mid-1957.

Societa Purfina Italiana and the **Italian Government** are planning construction of a new refinery in Rome. It will be known as Raffineria di Roma and will replace existing Rome refineries which are to be closed for reasons of town planning. The joint operating company Raffineria di Roma was formed by Purfina Italiana and Anic, a subsidiary of the E.N.I. group.

British Hydrocarbon Chemicals, Ltd., has announced that its two new plants for the production of ethylene and ethanol are now in commercial operation, and have doubled the previous capacity. Decision to construct the two plants was announced in June, 1955, as part of the expansion program at Grangemouth.

Callery Chemical Co. has broken the ground for what it calls the world's largest high energy fuel plant. The plant, which will cost about $38 million, will make high energy boron compounds. A contract for the construction of the first units of the plant which will be located in Muskogee, Okla., has been awarded to T. C. Bateson Construction, Dallas.

Tidewater Oil Co. has placed on stream its large reforming unit at its new refinery in Delaware City.

The unit is a 45,000 barrels-per-day Houdriformer. It is the primary component of an installation designed to produce clear gasoline rated at 100-octane or higher. The giant Houdriformer, constructed by C. F. Braun & Co., will be operated on a wide range of feed stocks,

For more data on advertised products, use Readers' Service Cards, last page.

Only connoisseurs of the best

and we mean those experts of the Petroleum Industry who determine the choice of the right catalyst

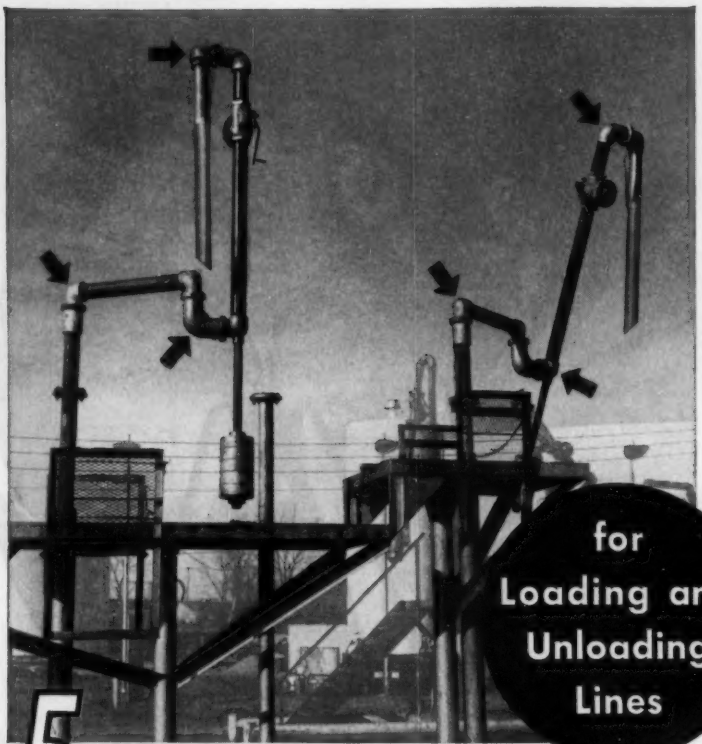
can appreciate our "Recipes" the fine nuances and painstaking care of our production program.

We furnish to the Petroleum Industry catalysts for cracking and reforming

particularly for TCC-, Houdriflow- and Catforming-plants

KALI-CHEMIE AKTIENGESELLSCHAFT **HANNOVER**/GERMANY

BARCO Swing Joints and Assemblies



for Loading and Unloading Lines

5 Reasons for SUPERIORITY!

1. **BALL BEARING AND O-RING EQUIPPED**—Designed specifically for handling gasoline, oil, lube oil, LP gas, petro-chemicals, and other petroleum products.
2. **LARGE BEARING SURFACE**—Barco's bearing design provides adequate support for lengths of piping. Minimizes bearing pressures and wear.
3. **CONTROLLED TORQUE**—No annoying, uncontrolled swinging of lines. They swing easily but stay put.
4. **LONG LIFE**—New "Bar-Moly" dry lubricant process gives a permanent anti-galling, corrosive-resistant finish to moving parts. This, combined with routine lubrication, insures longest possible maintenance-free service.
5. **EASY MAINTENANCE**—Joints can be disassembled for inspection without disconnecting piping. O-rings are easily renewable in the field. No greasing is required to maintain sealing.

The Barco line is complete with single swing, double swing, and counter-balance styles and assemblies to meet every need. Sizes 1", 1½", 2", 2½", 3", 4", 6", and 10". All steel or malleable iron. Send for latest Catalog No. 400 containing engineering and ordering information. *Worldwide sales and service.*

BARCO MANUFACTURING CO.
542-F HOUGH STREET
Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

Who's Building...

predominently naphthas from Middle East crudes. Product of the Houdriformer is fed to an aromatics extraction unit, and a recycled stream of raffinate from the extraction section is mixed with the fresh feed to the Houdriformer.

The Farmers Union Central Exchange, Inc., is installing a Uniforming unit and Platformer at its 19,000 bpd refinery at Laurel, Mont. The Platformer will process about 4500 bpd of gasoline and the Unifiner will handle 7000 bpd of intermediate products. A new boiler and cooling tower will also be added. The two units are part of a $3 million improvement program which is expected to be completed in early 1958.

Utah Oil Refining Co. has planned a construction program that will cost approximately $4.2 million. Most of the money will be spent in improving the company's 29,000-bpd refinery at Salt Lake City. Major item on the program is the construction of a carbon monoxide boiler.

Diamond Alkali Co., will build a new plant to produce 50 million pounds of vinyl chloride annually at the company's Deer Park, Texas, facility. The new plant which is scheduled for completion early in 1958, will cost approximately $10 million.

The company said the monomer plant is being built to meet the rapidly increasing demand for its PVC resins. Officials at the company's headquarters in Cleveland listed the new plant as part of a major expansion program which will also include construction of a unit to produce acetylene from natural gas.

During the five-year program, Diamond Alkali's capital expenditure will total $60 million or more, most of which will be concentrated in the Deer Park area.

W. J. Butler, works manager at Deer Park said the new project will be built on a 300-acre plus tract on the Houston Ship Channel. The plant will be designed by Scientific Design Co., New York, and will be built by Brown & Root, Inc., Houston.

Southern Nitrogen Co. has gone into partial production at its new $14 million nitrogen plant at Savannah. The plant is now making ammonia and nitrogen solution, and will be making ammonium nitrate by next month. Ammonia capacity of the plant is rated at 250 tons a day.

Air Reduction Co. has broken ground at Bassett, Calif., on a new $7.5 million air separation plant. The plant will produce 55 tons of high purity oxygen, 15 tons of liquid nitrogen, and 3.5 tons of liquid argon a day. It will be completed late this year.

Rheinische Olefinwerke G.m.b.h. of Wesserling near Cologne will expand the capacity of its Lupolin (high pressure polyethylene) plant from approximately 10,000 to between 30,000 and 35,000 metric tons a year. The expenditure is estimated to be about 32.9 million, with probable completion date scheduled for around the end of 1958. Ethylene will be

NEW HOOKER MANUAL helps you store and handle caustic soda safely

This new manual gives you 40 pages of information and advice on how to handle and store liquid caustic soda safely, efficiently, and with minimum risk of contamination.

Here are some of the contents:

- ✓ Large, detailed diagrams of equipment to use in unloading, diluting and storing.
- ✓ Commonly used methods for unloading a tank car of liquid caustic soda, for diluting to different strengths, and for storing.
- ✓ A section on safety precautions and first aid.
- ✓ A section on materials of construction.
- ✓ 18 charts, graphs and tables to help you predict and control the behavior of liquid caustic under a wide range of operating conditions. These cover such properties as dilution temperature, vapor pressure, viscosity, specific heat, etc.

For your copy of this new manual, write us today or use the coupon.

HOOKER CHEMICALS PLASTICS

HOOKER ELECTROCHEMICAL COMPANY

Niagara Falls • Tacoma • Montague, Mich. • New York • Chicago • Los Angeles

HOOKER ELECTROCHEMICAL COMPANY
1605 Forty-seventh Street, Niagara Falls, N. Y.

Please send me a copy of Bulletin 102, *Caustic Soda Engineering and Handling Guide.*

NAME.....

TITLE.....

COMPANY.....

STREET.....

CITY.....STATE.....

SEASONED EXPERIENCE AND EXPANDED FACILITIES

. . . Try Bird-Archer Water Treatment Service

This is a corner of Bird-Archer's new laboratory in Philadelphia where speed and capacity to run tests of water samples has been doubled. Additional facilities and field personnel extend the benefits of Bird-Archer's popular 8-Point Water Treatment Service over a greater area than ever before. This program includes services helpful to you if you are not already a Bird-Archer client.

8 POINT WATER TREATMENT SERVICE for Power, Process and Cooling

1. Study of Water Availability and Supply
2. Survey of Plant and Process
3. Scientific Laboratory Analysis of Samples
4. Development of Treatment and Control System
5. Custom Formulation of Chemicals
6. Recommendations and Specifications for Equipment
7. Instruction of Plant Staff in System Application
8. Periodic Check-Ups by Field Service Engineers.

60 years' reputation for the highest quality chemicals and sound engineering in water treatment are your insurance in your investment in Bird-Archer service. Let a Bird-Archer man "trouble-shoot" your problems in water and steam control. Write for a copy of our free book, "Industrial Water Treatment" and the name of our nearest representative.

BA601

SEND FOR THIS CATALOG ALSO

BIRD-ARCHER
WATER TREATING ENGINEERS
THE BIRD-ARCHER COMPANY, 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.
New York, Chicago
The Bird-Archer Co. of California, 881 Mission St., San Francisco
Offices also in Canada and Mexico

Who's Building . . .

produced in a special plant apart from the ethyl benzene.

It is possible that the firm will produce further ethylene polymers related to Lupolin, or suitable for expanding the range of polyethylene applications. Parent companies of Reinische Olefinwerke are Badische Anilin & Soda-Fabrik AG., Ludwigshafen A. Rhein, Germany, and Deutsche Shell AG., Hamburg.

Phillips Petroleum Co. has begun full-scale production at its 75 million pound a year polyethylene plant on the Houston Ship Channel.

A 180 million pound capacity plant adjacent to Phillips' Sweeny, Texas refinery will supply the new plant with raw materials.

Excelsior Refineries, Ltd., Edmonton, Alberta, has announced that the company has acquired a 170-acre refinery site at The Pas, Manitoba. Construction of the plant, however, which will have a 1000-bpd capacity and will cost an estimated $1.5 million, will not be undertaken for some time. Crude for the plant will be supplied from the Saskatchewan and Manitoba oilfields.

The Atlantic Refining Co. will construct a new 2100-bpd alkylation unit at its Port Arthur, Texas, refinery. This unit, the third of its kind built by the company, will produce a high octane component for the company's Atlantic Imperial gasoline.

Raw materials for the new unit will be obtained from an existing catalytic cracking unit and from two Catformers. One of the Catformers, a new 15,000-bpd unit, is now under construction and will go on stream in July of this year. Although the over-all refinery capacity of 62,000 bpd will not be increased, a greater proportion of high octane gasoline will be made available.

Construction of the new alkylation unit will start promptly, and completion is expected in the spring of 1958.

Chemical Construction Corp., engineering and construction firm, will design a new ammonia plant for Befu Chemical Co., Ltd. in Japan.

The plant will be built by Befu at its factory site toward the southern end of Honshu Island overlooking Befu harbor. Chemico has contracted to furnish basic engineering services for gas generation facilities, using the Texaco process for the partial oxidation of oil.

Befu Chemical Co., Ltd., known as the Sumitomo-Taki Chemical Co., Ltd. prior to 1946, remains the biggest producer of ammonium sulfate in the Kinki District of Japan.

Mobil Overseas Oil Co., Inc., has announced plans to build a new 65,000-bpd refinery in Turkey. The refinery, scheduled to go on stream in 1960, will be built, as requested by the Turkish government, by a group of companies composed of Mobil Overseas Oil Co., Inc., the British Petroleum Co., California Texas Corp. and the Royal Dutch Shell Group under arrangements recently concluded with the Turkish government.

The initial installations will include a

75 Years of Progress

A world-wide organization ready to serve you

In May, 1882, Mahlon E. Layne drilled his first water well, thus beginning an organization that would become world-wide and world-famous. He designed the Layne Vertical Turbine Pump, Layne Shutter Screen and Layne Gravel Wall Well. These are recognized today for their combined unfailing performance in producing water for the world.

Layne has always accepted the challenge of leadership. Engineering advances and research have guided our organization from the beginning. This is the pattern which has earned Layne the reputation for world-wide leadership. We owe this leadership to the trust our valued customers have placed in our organization.

Call on your nearest Layne Associate Company

DOMESTIC

LAYNE-ARKANSAS COMPANY
Stuttgart, Arkansas

LAYNE-ATLANTIC COMPANY
Norfolk, Virginia

LAYNE-CENTRAL COMPANY
Memphis, Tennessee

INTERNATIONAL WATER CORPORATION
Pittsburgh, Pennsylvania

LAYNE-LOUISIANA COMPANY
Lake Charles, Louisiana

LOUISIANA WELL COMPANY
Monroe, Louisiana

LAYNE-MINNESOTA COMPANY
Minneapolis, Minnesota

LAYNE-NEW YORK COMPANY
Linden, New Jersey

LAYNE-NORTHERN COMPANY
Mishawaka, Indiana

LAYNE-NORTHWEST COMPANY
Milwaukee, Wisconsin

THE LAYNE OHIO COMPANY
Columbus, Ohio

LAYNE-PACIFIC, INC.
Seattle, Washington

LAYNE TEXAS COMPANY, INC.
Houston, Texas

LAYNE-WESTERN COMPANY
Kansas City, Missouri

GENERAL FILTER COMPANY
Ames, Iowa

FOREIGN

INTERNATIONAL WATER SUPPLY, Ltd., London, Ontario, Canada
SOCIETE FRANCAISE de FORAGES (Layne France Cie.) Paris, France
CIA. ARGENTINA PRODUCTORA de AGUA S.R., Ltda., Buenos Aires, Argentina
LAYNE VENEZUELA C.A., Caracas, Venezuela
L'HYDRAULIQUE-AFRIQUE, Beyrouth, Lebanon
L'HYDRAULIQUE-ASIE, Paris, France-Saigon, Indo-China

SUBSIDIARY

LAYNE PUMPS, INC.
Lubbock, Texas

LAYNE IRRIGATION COMPANY
Kearney, Nebraska

LAYNE MANUFACTURING COMPANY
Doud, Texas

1882 — 1957
Layne
75 YEARS OF PROGRESS

LAYNE & BOWLER, INC. MEMPHIS

General Offices and Factory • Memphis 8, Tennessee

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

Who's Building...

crude petroleum distillation unit and a catalytic reforming unit for upgrading naphtha. These units will be designed to process Middle East and Turkish crude, and will produce automotive gasoline, kerosine, diesel fuel oil and heavy fuel oil to meet the requirements of the Turkish market.

It is estimated that the cost of the new refinery, excluding the cost of land, will be $48 million which will be provided by the four companies. Of this total, it is estimated that $13.5 million will be spent in Turkey. The exact location of the refinery will be determined before the end of June 1957.

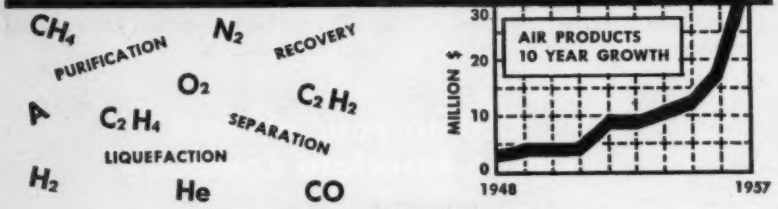
The four participating companies will form a jointly owned refinery company incorporated under the laws of the Republic of Turkey. Mobil Overseas will have a 37 percent interest, Caltex 34 percent, Shell 18 percent, and British Petroleum 11 percent in the refinery.

Along with an existing refinery at Batman in southeastern Turkey, which is owned and operated by the Turkish government, the new facility will be sufficient to meet all of Turkey's needs for petroleum products. It will process imported crude oil until production of domestic crude oil substantially increases.

The right to operate the refinery will be for a period of 80 years with a right of renewal.

CHEMICAL & MECHANICAL ENGINEERS

are offered opportunity to advance professionally in diversified growth company



LOW TEMPERATURE PROCESSING

The Company is the leader in the engineering, design, manufacture and construction of plants and systems for the separation of gases such as Oxygen, Nitrogen, Carbon Monoxide, Hydrogen and other low boiling building blocks of the chemical industry. We must expand the entire organization to meet the increasing demands of the steel, metallurgical and chemical industries, and for national defense.

Selected Assignments

- PROCESS DESIGN ENGINEERS
- RESEARCH & DEVELOPMENT ENGINEERS
- PROJECT ENGINEERS
- ESTIMATING & ECONOMIC EVALUATION ENGINEERS
- MECHANICAL ENGINEERS
- DESIGN ENGINEERS
- CONSTRUCTION ENGINEERS
- FIELD OPERATIONS MANAGER
- OPERATING SUPERINTENDENT
- MANUFACTURING & PROCESS ENGINEER
- SALES ENGINEERS

AIR PRODUCTS, INC., situated in Eastern Pennsylvania at the foothills of the lovely Pocono Mountains, with ready access to three fine universities as well as other cultural and recreational facilities, offers you . . .

1. High professional salary scale.
2. Company paid advanced educational program.
3. Unusual medical and life insurance program.
4. Bonus and profit sharing opportunities.
5. Fine retirement plan.

At AIR PRODUCTS you will work with recognized leaders in the industry.

Send resume in confidence to Mr. E. J. Strobel

Air Products
. . . INCORPORATED

P.O. Box 538 Allentown, Pa.

Texas Natural Gasoline Corp. has completed its field processing plant at Glendive, Mont. The plant is processing about 6 million cubic feet of natural gas daily with residue being sold to Montana-Dakota Utilities Co. Initial capacity for natural gas liquids is 50,000 gallons daily.

Louisville Refining Co. has placed on stream Kentucky's first UOP Platforming and Unifining units as a combination facility.

The combination unit has a design capacity of 2000 bpd. Straight run and thermally cracked gasolines, derived from Mid-Continent crude are charged to the Unifining section to prepare feed stock for the Platformer. The Platforming unit is designed to produce a 99 leaded octane Platformate for use as a blending component in premium gasoline.

The combination unit was designed, engineered and licensed by Universal Oil Products Co.

Mobil Oil of Canada, Ltd., and **Shell Oil Co.** will both probably build plants for extracting sulfur from natural gas in the Calgary, Alberta, Canada region whenever the gas production warrants them.

The Mobil Oil plant would have a capacity of around 350 long tons of sulfur daily, and would be built by Jefferson Lake Sulphur Co. The Shell plant would probably produce about 300 long tons a day.

The stripped gas would be available for export or for use on the Canadian domestic market.

Columbian Carbon Co. and **Celanese Corp. of America** together will make carbon black in Brazil. The two firms have joined with Companhia Petroquimica Brasileria and will erect a $30 million pound-a-year plant near San Paulo. They hope to be in operation by early 1958.

Monsanto Chemicals, Ltd., which is two-thirds owned by the U. S. Monsanto Chemical Co., plans to build a $23.8 million petrochemical plant at Fawley, near Southampton, England. In order to raise $14 million to partially finance the plant which is to produce polyethylene, acrylonitrile and its copolymers, holders of the present common stock will be given the right to buy $5.67 million worth of new issue on the basis of one share for each two held. This means that the U. S. Monsanto Chemical Co.'s share of the subscription will be $3.78 million.

A stock dividend of 5.4 million shares will be issued on a one-for-three basis later in the year. An $8.4 million long term debt offering also scheduled for later in the year, along with the British firm's retained earnings and depreciation reserves, will supply the remainder of the money required to build the plant.

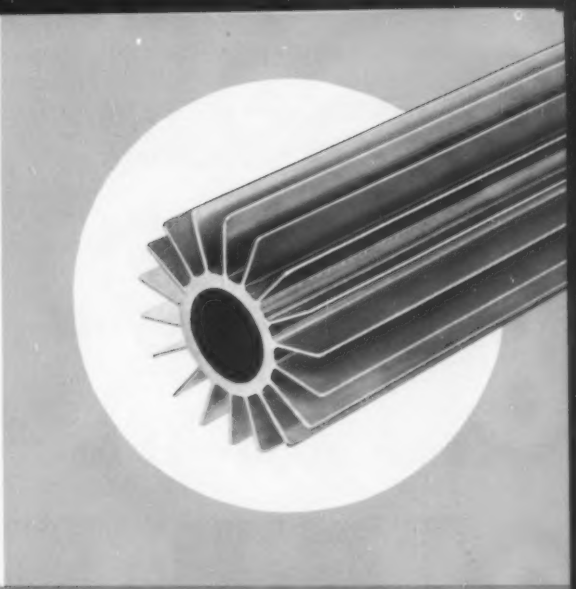
Phillips Petroleum Co.'s wholly owned subsidiary, Phillips Chemical Co., has begun large-scale commercial production of its highly versatile, rigid-type polyethylene. Tonnage quantities of the new plastic have started moving to fabricators throughout the country from Phillips chemical manufacturing site on the Houston Ship Channel.

Capacity of the polyethylene plant is scheduled to reach 75 million pounds per

There is one type of

HEAT TRANSFER SURFACE

best suited to your next heat exchanger.



G-R can impartially and authoritatively tell you which

In some cases, *bare tubes* may be the most practical type of heat transfer surface for your needs. In other cases, *finned tubes* may provide a more efficient and compact exchanger.

G-R builds heat transfer apparatus with *either* bare tubes or finned tubes. G-R finned tube surfaces include both longitudinal G-Fin and helical K-Fin . . . two widely popular types that have proved their superiority in hundreds of thousands of installations throughout the world.

G-R builds both shell-and-tube units and open sections . . . for large or small capacities . . . for high or low temperatures and pressures . . . for clean or clogging fluids, with high or low heat transfer rates. Your problem involves some of these conditions. G-R engineers have met all these conditions in all of their combinations. Let us advise you. Call in a G-R representative today.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

HERE'S AN EXAMPLE OF G-R LEADERSHIP IN HEAT TRANSFER APPARATUS

561

Name your test for heat exchangers

and apply it to

G-R Twin G-Fin Sections

Is it the DESIGN test?

G-R Twin G-Fin Sections are the simplest form of heat exchanger—a pipe within a pipe, with head end closure consisting of only 4 parts.

Is it the ADAPTABILITY test?

More than 80,000 G-R Twin G-Fin Sections are in use on a wider range of heat transfer services than any other design of heat exchanger on the market.

Is it the BACKGROUND test?

G-R Twin G-Fin Sections have been on the market for 25 years, and their design and construction are based on 90 years of experience in building heat transfer apparatus.

Is it the PERFORMANCE test?

Many thousands of G-R Twin G-Fin Sections have been in service for 10 years and longer with negligible maintenance cost and without replacements of any kind.

Is it the EFFECTIVENESS test?

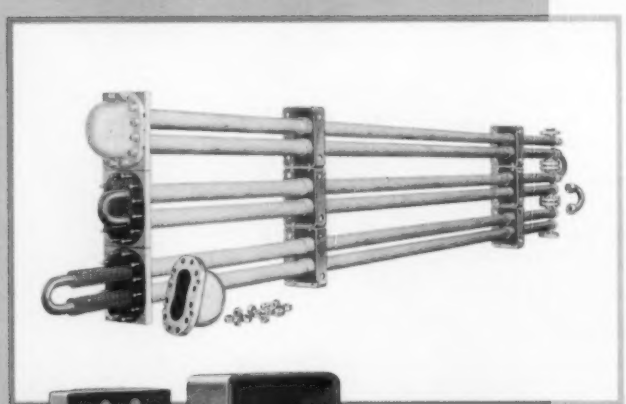
The G-R Twin G-Fin Section has elements with longitudinal G-Fins that have 6 to 8 times the external transfer surface of bare tubes, thereby permitting fewer tubes to handle services in which the two fluids have unequal heat conductivity.

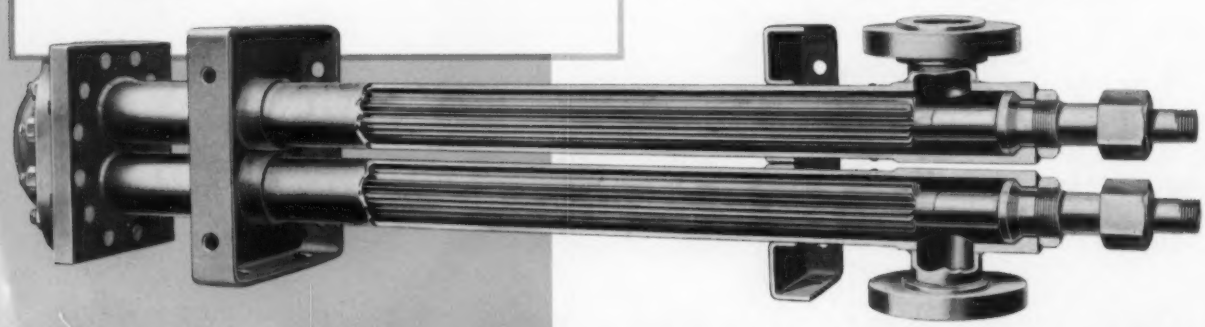
Is it the RATING test?

The long and extensive experience of the G-R engineers in heat transfer, and the operating results of the many tens of thousands of G-R Twin G-Fin Sections in service assure ratings which are authoritative and dependable and can be guaranteed.

Is it the CONVENIENCE test?

G-R Twin G-Fin Sections are standard and interchangeable. They are easily handled, can be shifted from one kind of heat transfer service to another, can be installed in series or parallel to suit the desired capacity and temperature range, and sections can be added or removed to meet changes in operating conditions.





Write for bulletin describing these "universal" heat exchangers in detail.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

GR370

year during the last half of the year as additional equipment is placed in operation. An ethylene plant of 180 million pounds initial capacity adjacent to Phillips Petroleum Co.'s Sweeny refinery will supply the basic material through a 75-mile pipe line. Underground caverns washed from deep salt formation, near the Sweeny refinery, will store ethylene.

Asahi-Dow, Ltd. has commenced production of polystyrene at the new Kawasaki plant according to an announcement by Dow Chemical International, Ltd., and Asahi Chemical Industry, Ltd.

This newest addition to Japan's rapidly-growing plastics industry was completed two weeks ahead of schedule. It is the second joint venture undertaken by Asahi Chemical and Dow Chemical who joined to form Asahi-Dow Limited five years ago.

The new Kawasaki plant, situated between Yokohama and Tokyo, received its first shipment of styrene monomer in January. This shipment was reportedly the first bulk shipment of monomer from the United States to Japan and comprised 3.36 million pounds.

Dow International reported that from the time the original agreement was drawn up in 1954 until the engineering began, the size of the Kawasaki plant doubled.

Akita Petrochemicals Co., jointly formed last November by Teikoku Oil and Sumitomo Chemical, will start construction of a methanol plant in June in Tsuchikaki Prefecture. The plant will have a capacity of about 2500 tons a month, and will use gas from Teikoku's Yabase field.

The Texas Co. has completed the new product control laboratories at its Port Arthur Works. The laboratories occupy 46,000 square feet of floor space in two separate buildings.

Five years of planning and construction, along with the engineering experience and ideas of many different companies, including the various departments of The Texas Co., went into the building of the Texaco laboratories.

Over 1500 samples are processed daily through the product control laboratories. The majority are product samples from various points in the manufacturing and shipping departments. Samples also are received from the Port Arthur Research Laboratories, Texaco's Research and Technical department, and from other refineries of the company at distant points.

Cities Service Oil Co.'s third and largest UOP Rexforming unit yet built has gone into operation at the company's Ponca City refinery.

It has a design capacity of 6000 bpd and is processing a straight run gasoline, derived from Mid-Continent crude. The Rexformer is designed to produce a 95 clear octane debutanized Rexformate, for use as a blending component in Cities Service gasolines.

The unit was built by Procon Inc., which also is revamping the existing crude unit to increase capacity and fractionating ability. Universal Oil Products Co. designed, engineered and licensed the Rexformer.

The Texas Co. has placed on stream a viscosity breaker with a capacity of 13,000 barrels of vacuum residuum per operating day at its Eagle Point works, Westville, N. J. The unit will permit higher yields of furnace oil and reduced yields of residual fuel oil.

Cit-Con Oil Corp. will undertake a $4,000,000 expansion and construction program at its Lake Charles refinery. The improvement is expected to result in a 25 percent increase in the production of paraffin wax and a 20 percent increase in light oils.

Approval of the final plans was granted by Cit-Con's parent companies, Cities Service and Continental Oil Co., following an intensive cooperative study by Cit-Con technicians and engineers of the consultant firm of Tears Engineers, Dallas.

The project calls for expansion of several existing Cit-Con refinery components: the MEK units, vacuum distillation units, the furfural unit and cooling tower. Cit-Con made the move to keep abreast of present market demands for quality light oils and waxes.

Who's Building . . .

Phillips Petroleum Co. will add to the output of high-octane gasoline from its Sweeny, Texas refinery with construction of a second 16,000-bpd catalytic reforming unit.

Fluor Corp. will construct the unit. Construction is scheduled to start late this summer with completion set for early spring of 1958.

Besides motor fuels, the Sweeny refinery produces jet fuel, aviation gasolines, kerosine, a full line of heating distillates, diesel fuels, heavy fuel oil and liquefied petroleum gas products.

SURVEYS
CONSULTING
ECONOMICS
PROCESS DESIGN
MECHANICAL DESIGN
PROCUREMENT
CONSTRUCTION SUPERVISON
OPERATING ASSISTANCE

REFINERY SURVEYS

. . . ONE OF OUR SPECIALTIES

Far reaching changes are taking place in the refining field. Now may be the time to review your processing methods and facilities with an eye toward improved product quality and profitability.

What changes are desirable, feasible and profitable? A survey and analysis by our organization will provide the answers you need.

"In Engineering, it's the People that count"

THE C. W. NOFSINGER COMPANY
Engineers and Contractors for the Petroleum and Chemical Industries
906 GRAND AVENUE KANSAS CITY 6, MISSOURI

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 Madison Avenue New York 17, N. Y.

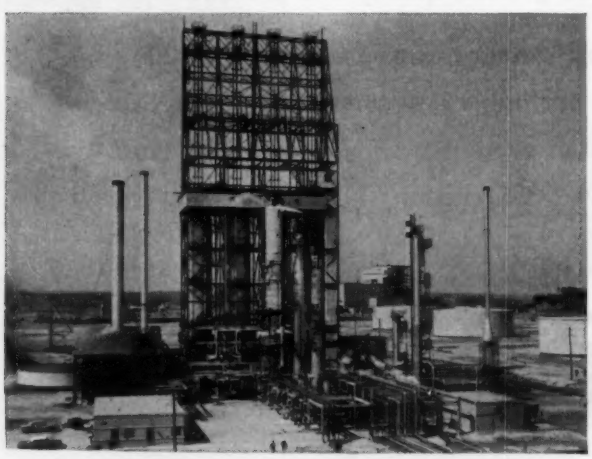
NEW AMOCO DELAYED COKER EXCEEDS EXPECTATIONS...RUNNING MOST DIFFICULT CHARGE STOCK

Lummus designs, engineers and constructs unique 4-coke-drum, 600 ton-per-day unit. Designed for vacuum bottoms containing 25% Conradson Carbon.

A Delayed Coking Unit which handles the heaviest feed ever charged is now in operation at the new Yorktown, Virginia refinery of The American Oil Company.

The unit has been in continuous operation since the initial firing on January 30, 1957, surpassing all guarantees of capacity of charge stock and product specifications, and has been formally accepted before completion of this run.

The fractionating tower produces light and heavy gasoline and light and heavy gas oils meeting all rigid Amoco specifications for the production of high octane unleaded gasoline. Coke produced meets client's specifications for pulverizing for use in boilers.



This delayed coker at Amoco's new Yorktown, Va. refinery handles the heaviest charge on record. Four coke drums measure 17'6" x 75' tangent to tangent. Refinery will help supply unleaded "Amoco-Gas" to an 18-state market.

Evaluation of charge stock in Lummus laboratories and pilot plants supplied the information for special design features that were incorporated into the heater—the heart of the process—and other critical equipment, to handle the heaviest charge stock on record. The unit was designed for a charge mixture of vacuum reduced crude with 25% Conradson Carbon, an API gravity of 6.1°, and an SFS viscosity of 6,000 at 210° F. It was also designed to process a variety of stocks at different recycle ratios to meet required flexibility.

The new unit, based on pilot plant work at Lummus laboratories, was designed, engineered and built by The Lummus Company, and was completed 10½ months after the piles were driven.

Lummus has designed much of America's coking capacity — 10 units — combined capacity of over 120,000 barrels per day.

Lummus engineers will be glad to show you how your next project can be designed to produce a maximum return on your capital investment.

THE LUMMUS COMPANY, 385 Madison Ave., New York 17, N. Y. *Engineering and Sales Offices and Subsidiaries:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Engineering Center:* Newark, N. J.

As Management Sees It . . .

Streamline Your Workload

Your most useful office fixtures may be the deadliest time wasters.

Robert E. Johnson, Vice President and Assistant to the President
United Air Lines
Chicago

About the Author

ROBERT E. JOHNSON, vice president and assistant to the president of United Air Lines, is an aviation industry veteran. He began his airline career in 1929 with the Boeing Airplane Co. In 1938, Johnson became director of advertising and publicity for United. In 1951, he was elected a vice president of United in charge of public relations, publicity and advertising activities. In 1953, he also assumed direction of United's sales administration. He was elected to United's board of directors in 1954.

ONE OF THE GREAT problems confronting management is the proper application of time. An 8-hour office day has only 480 minutes. But the average executive's work day is more than eight hours. However, if he is to be more productive, he must make the most of the office time available to him.

From one view point the very offices in which executives work represent obstacle courses in the path of increased management efficiency. The first element in an office that can create trouble is the desk.

Most executives have desks, most believe they need them in the transaction of their business, and perhaps that's so. Executives make a bee-line for the desk when they reach the office, and because it represents a symbol of office life, have a tendency to spend too much time in that one spot. As a result many executives are unable to accomplish some very important aspects of management responsibilities.

We all know that a desk is a trap for paper work. As long as a desk has a drawer or several drawers it's going to accumulate papers. Many executives practice the experiment from time to time called "cleaning out our desk" and it's always a revelation to discover how unimportant some of the material in the desk has become when on receipt it appeared so vital.

Some executives get around this problem by not using a desk. They found by using lounge furniture in their offices and perhaps a telephone table they've been able to escape some of the problems that are created by the desk. But whether you get rid of a desk or not is immaterial. The main point, and this is step one in the elemental do-it-yourself, is to recognize that you must be master of your desk rather than servant.

That Goes for Letter Baskets, too. The next familiar piece of equipment in our offices is what we might call the letter basket. It can be a letter box on the desk, it can be a drawer on the desk. It can be the folder that the secretary brings in, but it represents business correspondence and that represents another deterrent to maximum efficiency of management action.

Many executives have assistants and secretaries who are very helpful in screening out correspondence, in handling minor matters, in passing up only those things which require policy or action at management level. But correspondence is an insidious thing and unless guarded against, the executive will find he is spending more of those 480 minutes a day in correspondence that might well be delegated.

Another sore point is the abuse of correspondence that takes place. About two months ago our company conducted a very interesting experiment. We collected from the mailing department all of the mimeographed material, all of the sales bulletins, all of the reports that were sent out during the period of one week to our sales offices in the field, and that made quite a pile.

Another sore point is the abuse of correspondence that goes on.

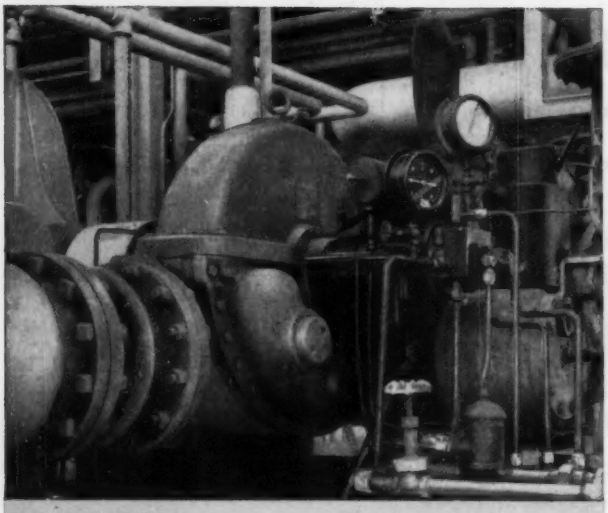
But as we went through that pile with the managers and supervisors who were responsible for creating that flood of paper to the field, we found that 50 percent of that material could either have been eliminated or pruned substantially! Yet it was eating up valuable time in its production and valuable time in the field. By the same token we examined the reports coming in from our sales offices in the field and found that a high percent were reports that no longer fulfilled their original purpose and others were susceptible to modernization.

These are three excellent solutions to the letter box bottleneck. Delegate as much correspondence as possible —handle what can be handled promptly—cut out unnecessary correspondence.

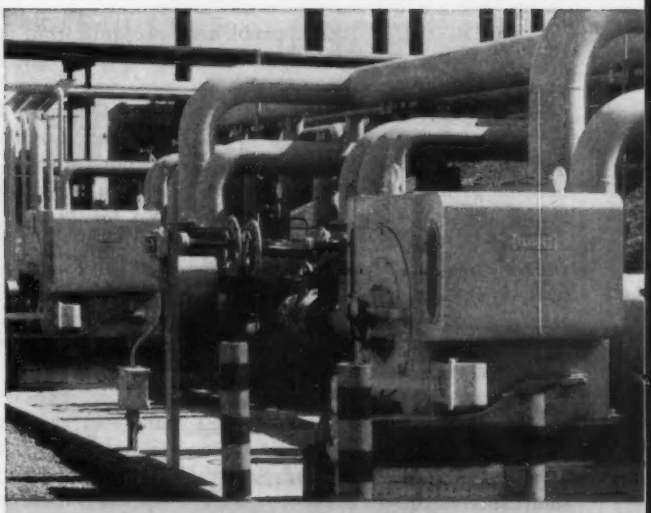
Then There's the Telephone. The third, and most time consuming piece of office furniture, is the telephone. We can't do business today without the telephone much as some of us

Continued on Page 324

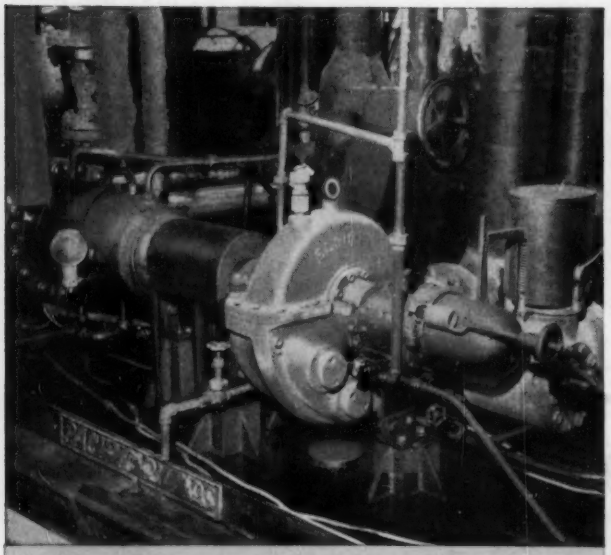
ELLIOTT serves



This Elliott 370-hp, 3240-rpm steam turbine drives a reciprocating compressor through a gear. The compressor serves a hydroformer unit.



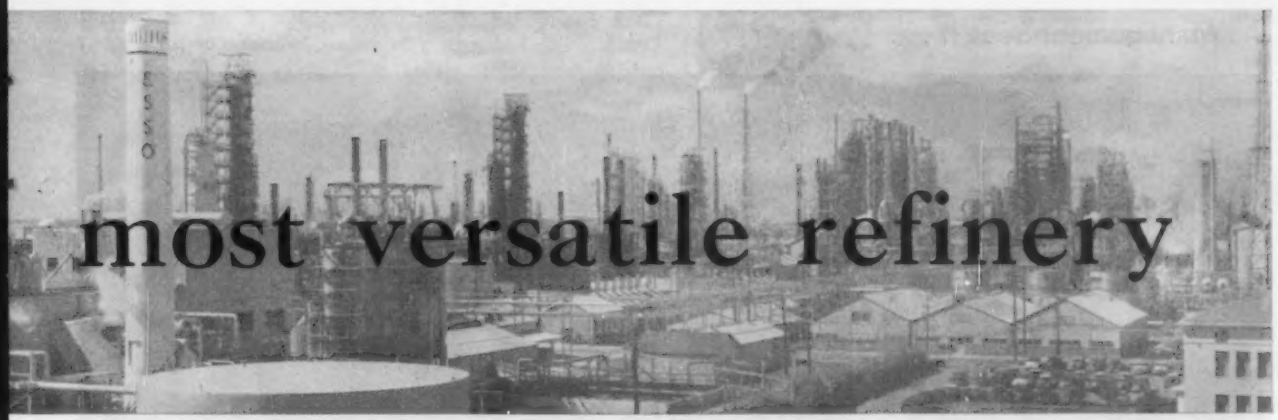
These two Elliott 450-hp weather-protected outdoor motors, located in the bluff area near the docks, are used to drive centrifugal pumps which handle heavy naphtha from adjacent tankage.



One of eleven Elliott turbines driving centrifugal pumps at a lube oil unit.

Here an Elliott 8-in. twin strainer handles river water at a lube oil unit.

For more data on advertised products, use Readers' Service Cards, last page.



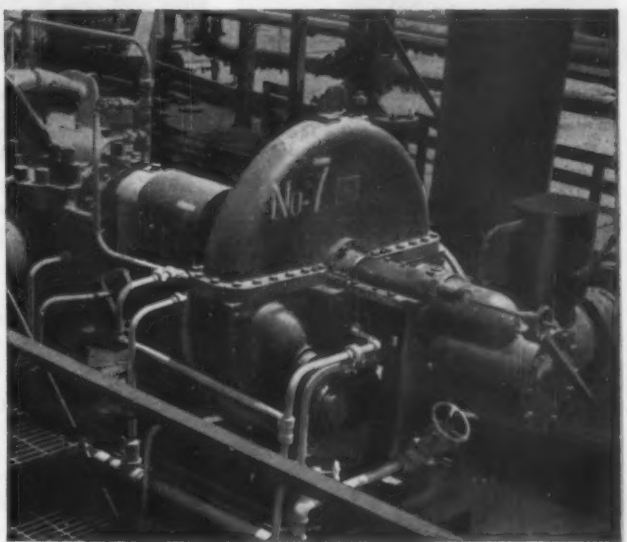
most versatile refinery

Esso Standard's Baton Rouge Refinery—producing more products than any other—is served by Elliott Turbines, Motors, Twin Strainers, Steam Ejectors, Deaerating Heaters

When this Esso Standard Oil Company refinery started operations in 1909, it processed 2000 barrels of crude oil per day into only three products. Now it converts 340,000 barrels of crude oil per day into over 600 products—a world's record in respect to number of products. It is also rated the largest refinery in the United States based on crude running capacity.

More than 100 Elliott steam turbines, ranging in size from 7 to 900 hp, are used in this refinery to drive all sorts of pumps, fans and compressors. Over a score of Elliott twin strainers, sizes 2 in. to 24 in., and Elliott steam jet ejectors serving vacuum units have been installed. Elliott 300-hp, 400-hp, and 450-hp motors are driving pumps and an Elliott 1750-hp, 1800-rpm induction motor is driving a centrifugal gas compressor. There are also four Elliott deaerating feedwater heaters.

Here is another dramatic illustration of how highest-quality steam and electrical products, manufactured by Elliott, serve leading industries. For information on how Elliott products can help you, call your nearby Elliott District Office or write Elliott Company, Jeannette, Pa.



Elliott Turbines, from small single-stage to large multi-stage types, assure highest-quality, long-term continuous service. This typical installation, operating on a 24-hour-a-day basis, is a 460-hp, 1750-rpm Elliott turbine which drives a river water booster pump. Bulletin H-228 describes the features which have resulted in the widespread use of Elliott YR turbines.

ELLIOTT Company

Q7-1

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

For more data on advertised products, use Readers' Service Cards, last page.

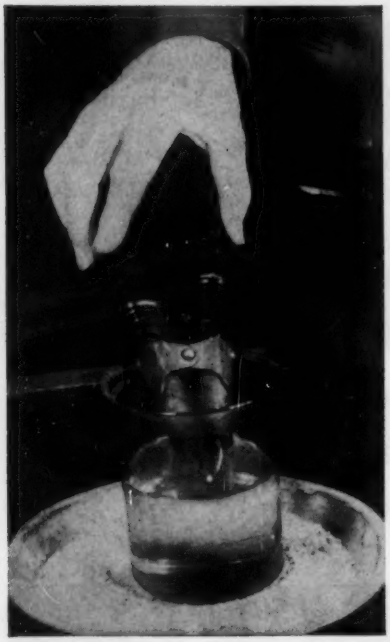


FIGURE 1—Even in open beakers, vapors above gasolines and JP-3 at 50 degrees F. are above explosive mixture vapor pressure. Therefore, they are too rich to burn in the container.

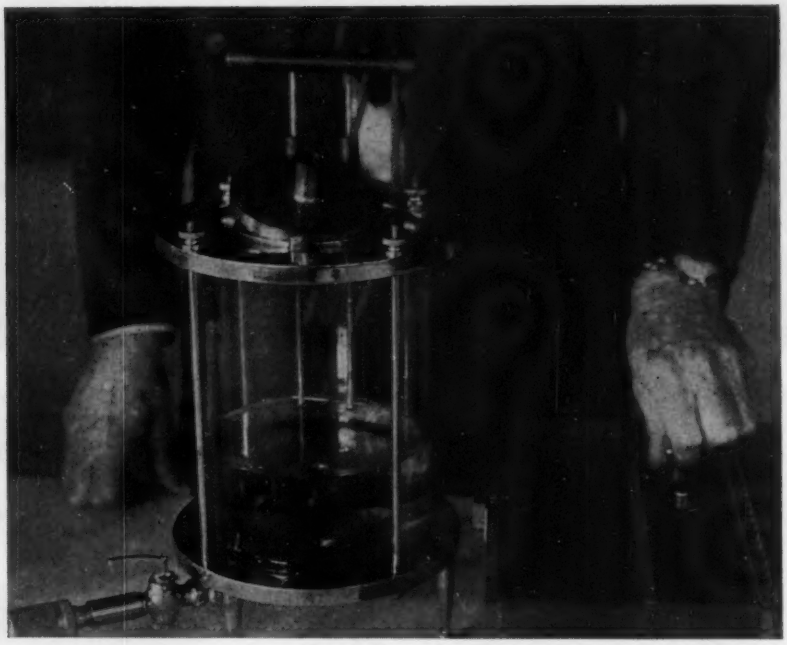


FIGURE 2—Small glass tank contains JP-R at a temperature of 50 degrees F. When spark was turned on above the liquid, fire occurred and the explosion disarranged the roof at the top. At this temperature the explosive mixture vapor pressure had not been exceeded. In these particular tests, however, the vapors would not ignite when the product was at or above 60 degrees F.

Safety and Fire Protection - - Part 5

How to Handle and Store Jet Fuels

Jet fuels are as safe as other products when handled and stored according to their characteristics.

J. L. Risinger, Maplewood, N. J.

THERE HAS BEEN concern during the past four years about the added hazards in handling and storage of jet fuels.

Some of these fuels produce vapors within the explosive range near the surface of a container or tank at temperatures which, in the case of gasoline, the vapors would be too rich to burn and kerosine and fuel oils, would be too lean to burn. Some fear arises because of not understanding the burning characteristics of these fuels.

An attempt is made here to evaluate the characteristics of these fuels in terms of their safe handling and storage. It is to be kept in mind that these fuels are simply petroleum products and they are as safe as other products when handled and stored in accordance with their characteristics.

Burning Characteristics. Many tests have been run, especially on JP-4, to determine when the vapors from this product are within the explosive or burning range, its flash point and other qualities which cause it to ignite under conditions slightly different from other products. Tests by various laboratories, Army, Navy, U. S. Bureau of Mines, individuals and others have not always come out to the same exact figures, because of variations in the product and conditions under which tests were made.

From a study of these tests, and some tests made by the writer, maximum of all ranges are used here. For instance, in the case of JP-4, tests made by the writer produced vapor in the container too rich to burn at 60 F., yet the maximum of other tests of 85 F. is used. It will also be noted that the old explosive range of the light products of from 1 percent to 6 percent by volume of vapor is not used, but the maximum range found by tests of the cracked and treated products.

Any plans for the safe handling and/or storage of petroleum or its products, must take into consideration the burning characteristics of the oil or gas involved. To

them must be applied flashpoint, boiling points and ranges, vapor pressures, explosive ranges and other characteristics. To the comparison herein made with other products is added the explosive range temperatures. By this is meant the range of temperatures at which the oil in a container will produce and maintain a vapor air mixture near its surface that will ignite and burn or explode when a sufficient volume of heat at the required temperature is applied. This has no relation to whether the flames would travel back through a conservation vent into a tank since the vapors at the surface of the oil no doubt would be too rich to burn at a temperature of the oil to provide a pressure sufficient to open the vent.

It will be noted that each of the jet fuels have flash points similar to other products which have been handled and stored safely for many years. Thus, it is simple to handle these products with the same precautions used when handling the other products. For instance, JP-3, JP-4, JP-R should be handled in similar manner as gasoline, for when spilled, or ignition is applied at their open surfaces in a pit, they will take fire at temperatures as low as 0 F.

However, of chief concern is the low vapor pressures of some of these low flash point jet fuels. In a tank, therefore, these vapors may be within the explosive range, whereas at the same temperature, the vapors at the surface of gasoline would be too rich to burn, the vapor pressure having purged the air to below the percentage required to burn. (See Figures 1 and 2.)

Vapor Pressure and Explosive Range. Whether an oil in a tank will give off vapors sufficient to ignite at its surface and whether the mixture at the point will be too rich in vapors is dependent upon the vapor pressure of the oil. (See Figure 3.)

A small vapor pressure will provide sufficient vapors. A higher vapor pressure will force out the air to below that required for combustion. For these reasons, vapors at the surface of gasoline are too rich to burn except at a very low temperature of the gasoline.

On the other hand, some mixed products containing light ends of gasoline, even though they have a low flash point, will not have a vapor pressure sufficient to purge out the air and become too rich to burn except at a high temperature. Since the vapor pressure is produced or increased with a rise in temperature and eliminated or reduced with a lowering of the temperature, the term vapor pressure is indefinite unless the temperature of the oil is also given.

The Reid vapor pressure method is calculated on the basis of an oil temperature of 100 F. The symbol for this test method is RVP.

It is interesting to note that the range of vapor pressures in which the vapors from a petroleum product is within the explosive range is very narrow and that the top limit of this vapor pressure, which brings the vapor mixture to the top explosive range, is low. This vapor pressure range which produces a mixture within the explosive range from its bottom to its top is slightly different with the difference in width of the explosive range.

As there is little variation in the explosive range of the light products here used, one common range of vapor pressures in which the vapors would be within the explosive range is all inclusive. The lower limit of this pressure is about .2 pound per square inch. To allow a slight safety margin, .18 psi is used. The upper limit is about 1.5 psi. However, to allow a safety margin 1.8 psi is used.

FIGURE 3—JP-1, JP-5 and kerosine do not produce vapor pressures to reach their bottom explosive limits at temperatures below 110 F. So when the torch is slowly submerged in them, it is extinguished instead of igniting the products.

At the RVP temperature of JP-4, the lower limit of vapor pressure of 2 psi, these vapors are above the top explosive range and therefore too rich to burn. Also, at the Reid vapor pressure temperature of JP-1 and JP-5, the vapor air mixture is still too lean to burn. (See Figure 4.)

The flash point of these oils in tanks are of little signifi-

FIVE KEYS TO SAFE HANDLING AND STORAGE OF JET FUELS

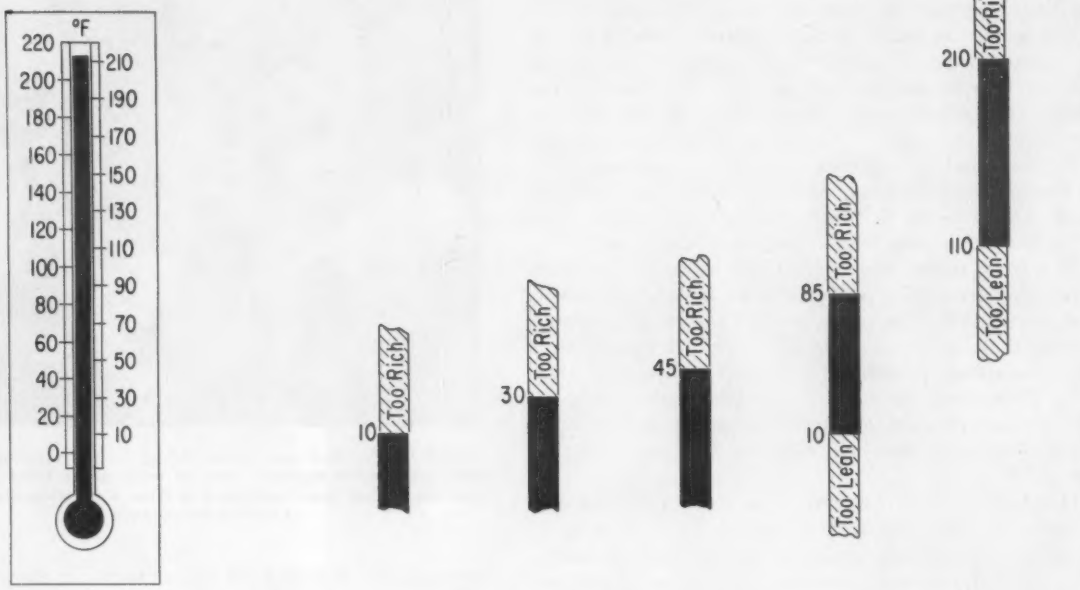
1. Safe handling and storage of jet fuels require consideration of their characteristics in the same manner as other petroleum products.

2. Safe handling of these products presents no special problem. JP-4 and JP-R produce vapors within the explosive range in a tank or container at a wide range of operating temperatures. Thus special provisions must be made to keep this explosive range from forming or to prevent static charge accumulation on the oil surface that would produce ignition sparks.

3. Where possible, JP-4 and JP-R should be stored in floating roof tanks and these roofs kept floating except during initial filling and repairs.

4. When these fuels are stored in cone roof tanks or when floating roofs are landed, extensive precautions are to be taken against turbulence and other factors that tend to accumulate static charges on the oil surface.

5. Bonding places the pipe through which hydrocarbons are flowing in the same potential with the container into which the oil is flowing, thus preventing an ignition spark. However, neither bonding nor grounding minimizes or affects the generation of a static charge on the surface of the oil.



Boiling Range	90—405	100—270	100—530	90—520	325—525
Reid Vapor Pressure	8—12	5.5—7	5—7	2—3	.1
Flash Point ASTM, °F	—0	—0	—0	—0	125
Explosive Limits, % Volume	1.4—7.6	1.1—7.2	1.3—7.8	1.0—7.0	0.7—6.0
Vapor Pressure Of Explosive Mixture	.18—1.8	.18—1.8	.18—1.8	.18—1.8	.18—1.8
Explosive Range Temperature	-0— +10	-0—+30	-0—+45	10—85	110—210
PRODUCT	MOTOR GASO.	AVIATION GASO.	JP-3	JP-4 JP-R	JP-1 JP-5 KEROSENE

FIGURE 4—Although N.F.P.A. explosive limits give these products a top limit of six percent volume of vapor, the U. S. Bureau of Mines scale calculated to take into consideration special condition possibilities are used. The bottom limit of explosive vapor mixture in kerosine, JP-1 and JP-5 takes into consideration the extreme conditions under which a mist (not vapors) might be present.

cance except to indicate the temperature from which to start in the producing a vapor pressure explosive range. The fire point, much higher than flash point in the low flash point oils, indicates the arrival at the lowest vapor pressure at which the vapor air mixture will be at the lower explosive limit of the oil.

In the chart, Figure 4, no bottom vapor pressure explosive range temperature is given for gasoline and JP-3. The temperatures at which an explosion or fire would be expected to occur would be somewhere between 10 and 30 F. below 0.

Chief Source of Ignition. The chief ignition source of any product in an all steel gas tight correctly vented tank is static charge on the surface of the oil at a rate faster than it can normally bleed off to the shell of the tank. To have a fire or explosion in one of these tanks from this cause, the vapor air mixture must be within the explosive range at the point and time that the triggering energy occurs in the form of the spark jump from the non-conducting surface of the oil to a conductor.

To prevent such a fire or explosion, the vapor air mixture in correct proportion to ignite, must be kept out of the correct balance. Another method is to avoid the accumulation of static electricity on the surface of the oil faster than it can normally bleed off to the shell, other structures and the atmosphere.

In the discussion of safe handling and storage of jet fuels the characteristics of these oils to produce the correct vapor-air mixture to ignite, how these vapors might be ignited by static spark, and the prevention of these coming together at the same time and place will be explored.

It is indicated that the jet fuels that are most often within the explosive range temperatures in most parts of the world are JP-4 and JP-R. As these fuels are in one classification, reference to JP-4 will also include JP-R and other jet fuels when handled and stored at temperatures at which the vapor-air mixtures is correct for fire or explosion within the container.

The vapor-air mixture above the oil in a tank can be kept out of the flamable range by supplying an inert gas

Klingerit gaskets keep joints tighter longer

Made specifically for high-pressure, high-temperature joints in Refineries and Chemical Plants, Klingerit Asbestos Sheet Packing costs LESS . . . because it lasts LONGER . . . Keeps plant production and efficiency up by practically eliminating costly downtime due to joint failures. Available from many conveniently located sources in thicknesses from ·008" to ¼" — sheet sizes to 60" x 160".

"Klingerit" — Universally used sheet packing for super-heated and saturated steam, hydraulic pressures, compressed air, gases, chemicals, oils, spirits and ammonia solvents.

"Klinger-Oilit" — Oil resistant sheet packing intended for use in oil refining and distributing as well as for use with methyl-chloride and sulphur dioxide.

"Klinger-Acidit" — Acid resisting sheet packing, produced especially to resist hot nitric, hydrochloric and sulphuric acids, as well as most other organic and inorganic acids.

"Klingerit 1000" — Wire reinforced sheet packing for extremely high pressures and temperatures. Specially suitable for cylinder head and exhaust joints in internal combustion engines, gas turbines, etc.

RICHARD KLINGER INC. 550, FOURTH AVENUE, BROOKLYN 15, NEW YORK
SOUTH 8-6747

Manufacturing Licensees for Canada

JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone: WILBANK 3181
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA26/57/3

in the vapor space to keep the oxygen content of the vapor space below that required. This space can also be kept too rich to burn by introduction of high vapor pressure flamable gases or vapors in to the vapor space.

The floating roof not only eliminates the vapor space but also the open surface on which a static electricity charge might accumulate. However, neither of these purposes are accomplished when the roof is not floating, but resting on its legs.

Static Electricity. For a static charge to be a source of ignition:

1. There must be a means of static generation. Examples of these are: separation of the trailing edge of a tire from the roadway upon which it is rolling; steam containing condensate or rust and issuing from a pipe; gases containing dust or rust and being discharged from a jet; and the discharge of hydrocarbons from the end of a pipe.

   Likewise, if a nonconducting liquid in a tank is subjected to turbulence, one portion of the material may be visualized as separating from another portion and static charges being generated. The latter two of these are the ones most involved in the problem of handling and storing of JP-4 and JP-R.

   Certain conditions either accentuate or mitigate the production of charges from the last mentioned source. These conditions include the type and degree of agitation or turbulence, and the presence and type of dispersion of water or other substances in the oil.
2. There must be a means of accumulation of a static charge on a nonconducting or insulated surface capable of producing ignition. Hazardous static charges can be accumulated only on a relatively well insulated body. The amount of accumulation of a static electricity charge depends upon the rate of generation and the rate of bleed off or discharge.
3. There must be a discharge of the accumulated charge across a gap or space to produce a spark or sufficient length to ignite. If the generation of static on an insulated surface is no faster than the capacitance to bleed or leak off, there will be no accumulation sufficient to produce the spark or ignition.

It is known that oil flowing through a pipe of a sufficient rate will accumulate a static charge sufficient to cause a static spark in a gap between the pipe and another conductor of a different potential. This is the reason for bonding the pipe to the container into which the oil is flowing, to keep the pipe and the container in the same potential.

Whether a static charge will be generated by a specific turbulence on one oil faster than on another has not been determined. It is known, however, that the rate of normal bleed-off is influenced greatly by the degree of conductivity of the oil, and the conductivity of the oil is increased by its water and impurity content. This is the reason for no experience of static accumulation on the surface of crude oil sufficient to cause a vapor explosion in a crude oil tank.

Bonding or grounding of the piping of the tank, or shell of the tank, will not minimize or effect the production of static electricity charge on the oil surface in the tank or lessen the difference in potential of these charges to the shell of the tank or other structures. Although bonding or grounding will prevent the receiving vessel from becoming charged, it serves no purpose in the prevention of the generation of a static charge on the surface of the oil, the reduction of the rate of its accumulation, nor prevent the production of an igniting spark from the surface of the oil to the shell of the tank or other structure.

In the prevention of static ignition of jet fuels flowing through pipes the same precautions are to be used in the case of JP-3, JP-4 and JP-R as for gasoline. However, in the case of filling a tank truck and other such container with JP4, there is a greater possibility of vapors being within the explosive range down in the container. Therefore, more emphasis should be placed on proper bonding between fill spouts and containers. In filling tank vehicles with JP-4, the fill stem should continuously contact the bottom of the compartment.

Storage in Floating Roof Tanks. The safest type tank in which to store JP-4 and JP-R is the approved floating roof tank. However, even when storing these fuels in floating roof tanks, certain precautions are to be observed. As long as the roof is floating, vapors within the explosive range (except under some type seals) is eliminated and open surfaces of sufficient area to accumulate dangerous static charges do not exist.

Since the vapor space under the seals of floating roof tanks containing these fuels are more likely to be within the explosive range, special attention should be given to roof design. Above all, there should be no vapor space under the seal subject to production of sparking from induced charge from lightning flashes. Extensive tests are being run by manufacturers on effective means of bridging the seal with a sufficient number and capacity channels to carry these charges to the shell above the seal.

In a number of the early floating roof designs, hangers above the seal, and network of wires between them apparently bled these charges to the shell and to the atmosphere to such an extent there were very few lightning ignited rim fires in these tanks. Some floating roofs are designed without vapor space under the seal.

In addition to attention to design, the following suggestions are offered for prevention of static ignition of JP-4 and JP-R in floating roof tanks.

1. Keep the roof floating at all times. Except when pumping out for repairs, never pump the tank below its landing so that there is an open surface below the roof.
2. At low levels, pumping in causes greater turbulence. Also at the start of pumping in there is more likely to be air or water in the line and other conditions may prevail which are more conducive to static accumulation on the surface of the oil than when the oil in the tank has greater depths.
   a. Pay special attention to filling the tank to roof floating depth by gravitating if possible, and if not, by pumping in at a very slow rate. The rate of three feet per second velocity should be maximum. The gallons per minute or hour can easily be figured on the basis of the size of the nozzle through which the oil is being pumped.
   b. When pumping in to the tank to float the roof, observe all of the precautions as though pumping in to a cone roof tank.
   c. Whenever possible avoid top gaging or sampling

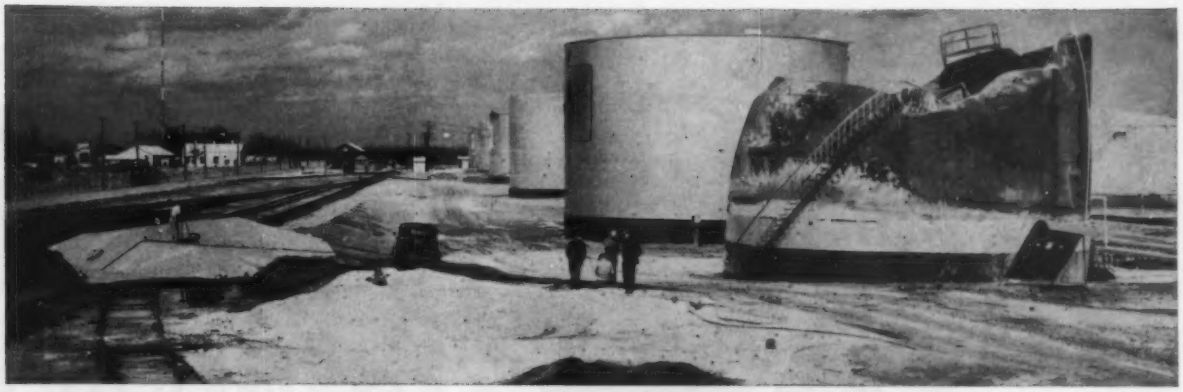


FIGURE 5—JP-4 was being pumped into this tank when roof blew and landed a distance away from the tank. An eight-foot depth had been attained when the explosion occurred. The JP-4 had a temperature in the 60's. Investigations indicated that the swing line was disrupted, delaying fire extinguishment. Fire was extinguished by use of 2½-inch foam nozzle.

when the roof is landed. Do not hand gage or sample in the usual manner a tank that is receiving, and in which the roof is not floating, until at least 20 minutes after in flow is stopped, thus permitting possible static charge to dissipate.

Storage of JP-4 and JP-R in Cone Roof Tanks. These products can be pumped into and stored safely in all steel gas tight cone roof tanks. In this case, there is a much greater probability of explosion than with the floating roof tank. Therefore, the trend toward storing in floating roof tanks should be as rapid as possible.

In the meantime, all precautions against accumulation of static charge on the surface of the oil should be taken, and all who pump in and store these products in cone roof tanks should be trained in correct procedure to prevent fires and explosions. Also, precautions should be taken for the protection of personnel should one of these fires or explosions occur.

The tanks should be correct in design and construction and maintained to this standard:

1. Avoid storing JP-4 in cone roof tanks. Where storing must be done in cone roof tanks, they should be of all steel, gas tight construction. They should be adequately vented with approved conservation vents or vents with flame arresters in accordance with the N.F.P.A. specifications for tanks containing oil with flashpoints not over 70 F.
2. The tank should be maintained with shell stronger than the roof so that in case of an explosion in the tank the roof will rupture or blow off without rupturing the shell below liquid level, or pulling the shell loose from the bottom.

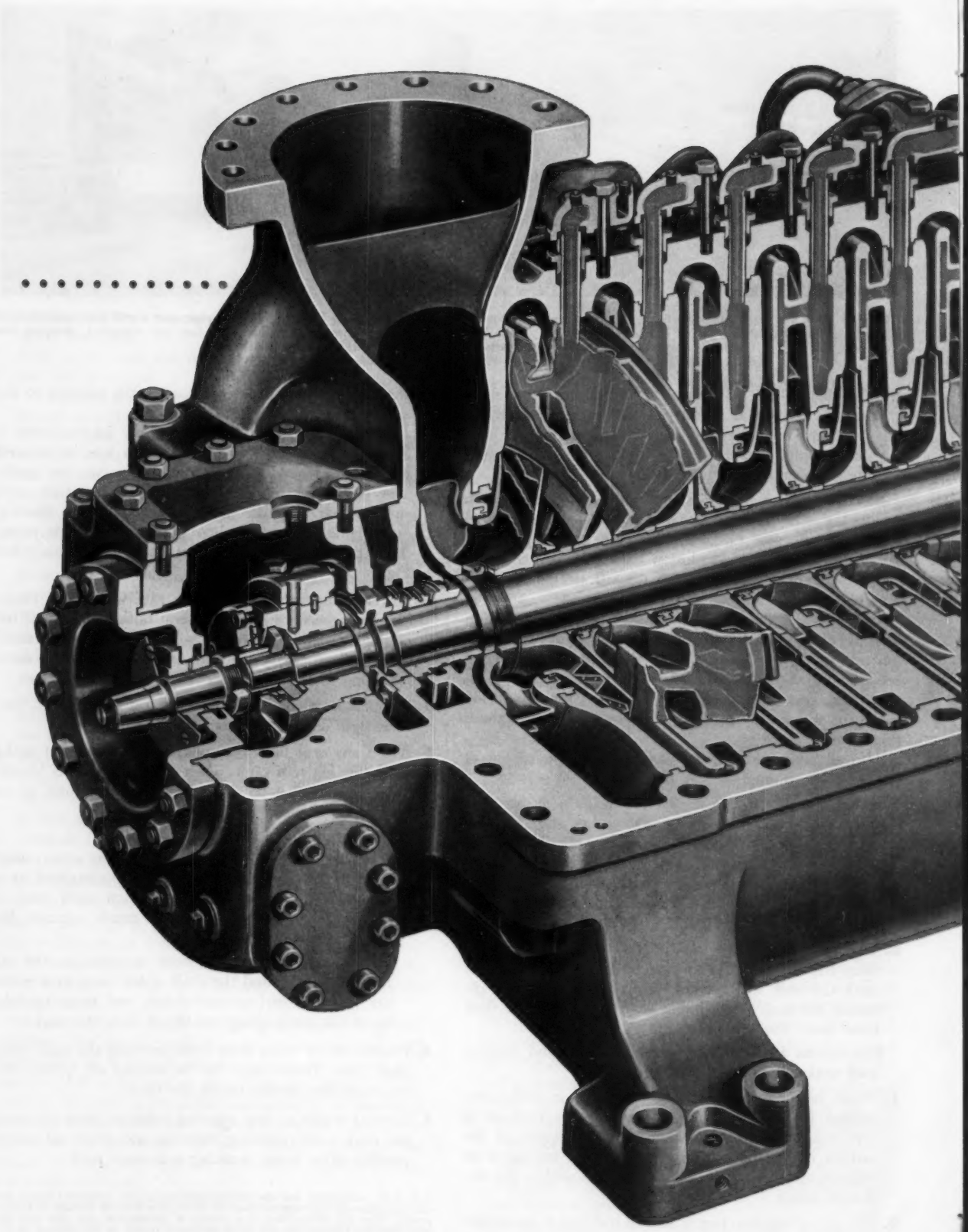
Precautions applicable to cone roof tanks and floating roof tanks when the roof is landed.

1. Water bottoms should not be permitted in tanks containing jet fuels. The agitation of these bottoms is very conducive to static charge accumulation on the surface of the oil and may thus cause explosion at temperatures in which the vapors are within the explosive range.
2. The prevailing practice of the oil industry is to always pump the products in to the tank through bottom terminating lines. This should be strictly adhered to in pumping JP-4 into a tank or introducing water into the tank for the purpose of floating the product to the suction line.

During 1955, a 30-foot tank blew its roof over a 35-foot high, electric line when water was introduced into a tank through a hose terminating two feet inside the top manhole. The depth of the product with similar characteristics as JP-4, was 8 inches floating on a water bottom. When pumping through swing line make sure the line is at bottom position. (See Figure 5.)

3. Never pump into a tank at a rate which will cause severe turbulence of JP-4. Limit outlet velocity of incoming stream to three-feet or less per second until roof of floater is floating, or in cone roof tanks until incoming nozzle is covered to a depth of six feet.
4. Never agitate the contents of the tank with open surface, with air, inert or flamable gases.
5. Avoid any type blending operations in cone roof tanks or in floating roof tanks when roof is landed. If blending of JP-4 must be done in cone roof tanks, or in floating roof tanks while roof is landed.
   a. Make sure there is no water bottom.
   b. Pump in gasoline-like stock first so that vapors near the surface of the product will be maintained at a vapor-air mixture too rich to burn until roof is floating or until oil is of safe depth against the blending turbulence.
   c. In such blending use devices to circulate the oil horizontally around the shell of the tank in a manner to avoid surface turbulence, and more rapidly bleed the static charge to the shell of the tank.
6. Prevent air or vapor slugs from entering the tank from pipe lines. These slugs can be vented off before the receiving line stream enters the tank.
7. Prevent water or any aqueous solution from entering the tank with receiving streams, and drain all water possible after water washing a storage tank.

It is to be understood that the findings and suggestions contained herein are my own although they may be summed up in some cases of findings of several groups. They are offered here as a matter of information only and with the hope that this information will be of assistance to you in the solution to the problem of handling and storage of products with similar characteristics as those described. With respect to the static electricity part of the story, reference is made to "Protection Against Ignition Arising Out of Static, Lightning and Stray Currents." American Petroleum Institute, 50 West 50th Street, New York 20, N. Y.—J. L. R.



For more data on advertised products, use Readers' Service Cards, last page.

CLARK

Diaphragm Cooling

- **Minimizes polymer formation**
- **Slashes horsepower requirements**
- **Greater safety handling hazardous gases**
- **Reduces capital investment**

Clark double-wall diaphragm cooling is the simplest, safest, and most effective way to intercool a multi-stage centrifugal compressor. Furthermore, polymer formation is minimized in the compressing of unsaturated hydrocarbon gases by the use of diaphragm cooling. It is a simple, economical method of maintaining gas temperature at the desired level in the capacity range of 1,000-30,000 CFM.

Power savings are an additional benefit of diaphragm cooling. The savings range from 20% on 15 molecular weight vacuum gas compressing applications to 5% for 110 psig. air compressors. Reduced installation and operating costs result.

Minimum capital investment is realized another way. Applications involving high compression ratios such as gas recovery and 120 psig. or less air compressors can be handled in a single case.

Diaphragm cooling also assures maximum safety when compressing oxygen, acetylene, and other difficult gases. Internal surfaces are always cool. Danger from potential hot spots is highly remote.

Clark builds a complete line of multi-stage centrifugal compressors and in many instances a gas turbine to drive them. Your nearest Clark representative has all the facts.

CLARK BROS. CO. OLEAN, N. Y.

One of the Dresser Industries

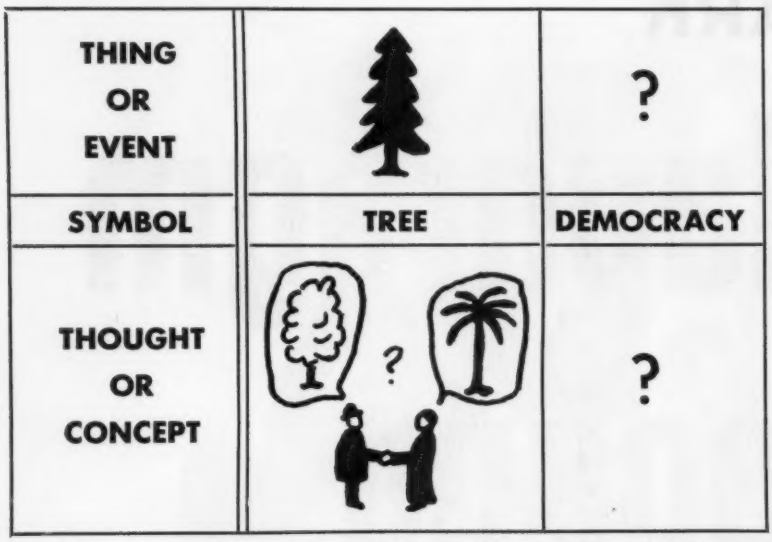
Offices in Principal Cities Throughout the World

CLARK

Centrifugal Compressors

Gas Turbines

For more data on advertised products, use Readers' Service Cards, last page.



Cartoon reproduced by permission from ETC., A Review of General Semantics, Vol. III, 201 (Spring, 1951).

A graphic portrayal of the problem of language of bridging the gap between things and thoughts. It is difficult enough to achieve this rapport with respect to simple physical objects, let alone abstract ideas such as democracy, justice and so forth.

How Well Do You Communicate?

Communication difficulties fall into two categories:

1. Communicants A and B do not use the same symbols to describe similar experiences.

2. A and B do not share similar experiences.

Anatol Rapoport
Mental Health Institute
University of Michigan
Ann Arbor, Mich.

WHAT YOU MEAN is inside you. It is a mixture of memories, mental pictures, desires, ideas about what is so and what isn't, about what should be and what shouldn't.

What you say is a disturbance in the air about you, which you have started by moving your lips, tongue and vocal cords. It should seem preposterous to expect an exact correspondence between the two sets of events. Yet we do expect it, else what do we mean when we expect to say what we mean? We take communication for granted, just as we take the smooth functioning of our bodies for granted. We become aware of either only if something goes wrong.

Something does go wrong often enough in communication. Difficulties of communication fall into two general categories:

1. The communicants *A* and *B* do not use the same symbols (words, expressions) to describe similar experiences; or

2. *A* and *B* do not share similar experiences.

The first situation is relatively easy to deal with; the second much more difficult. The simplest example of the first situation is a language difference. Both *A* and *B* eat, and eating is a similar experience for both. But *A*, speaking English, says, "eat," and *B*, speaking French, says, "manger." It is not hard for *A* and *B* to recognize that "eat" and "manger" mean "the same thing," and communication can be easily established by translation.

Even though the Tower of Babel had to remain unfinished because of the "confusion of tongues," ordinary linguistic differences are not a major obstacle to human communication. With a little training and a dictionary a German physicist can read a Russian physics journal, because the experiences of Russian and German physicists in their professional field are similar.

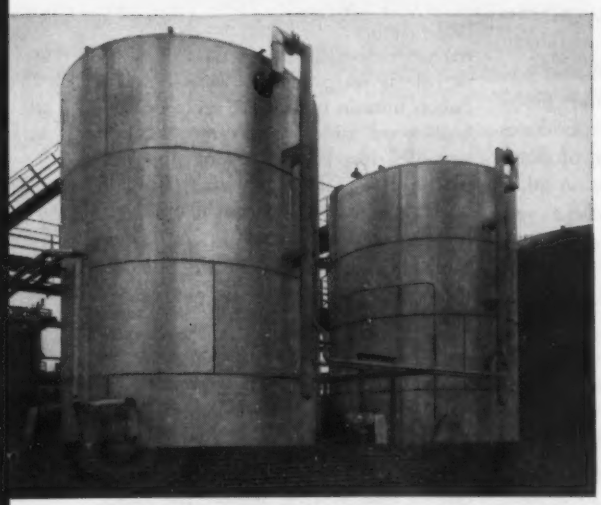
It is quite another story when *A* and *B* do not share a similar experience. No matter how carefully we define the "meaning" of blue, we cannot impart that meaning to a blind man. Attempts at careful definitions often confuse the issue still further, because an agreement on a formal definition often gives a false impression that the meaning of a word has been agreed upon. But the meanings are not in the words or in their definitions (which, after all, are only other words).

Meanings are in people, in the internalized experiences behind the words. If the experiences are not shared, neither are the meanings, and it seems to both parties that the other is distorting the meanings of words. When accusations of distortion are

Reflux condensers for soap neutralization, made from ⅛"-thick type 304 Stainless.

Not a Single Stainless Steel failure

in equipment for handling finished detergents



Synthetic detergent tanks (Stainless) have been in service for four years and are still as good as new. Previous coated tanks lasted 18-24 months.

The Atlantic Refining Company's Philadelphia refinery produces detergents as one of the derivatives.

Product contamination was the big problem. They tried sprayed-on plastic and phenolic coatings, but they all failed. Since they installed Stainless Steel, there has not been a single failure in the finished product handling equipment. There has been no corrosion problem. No contamination.

Nothing can equal Stainless Steel in its combination of properties: corrosion resistance, surface smoothness and denseness, strength and hardness, easy fabrication. Think of Stainless when you plan. Think of *USS* Stainless when you buy.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

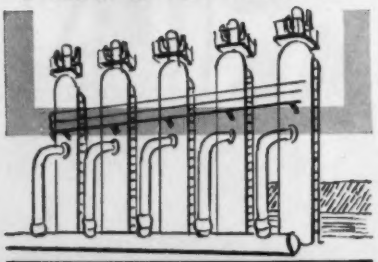
SHEETS • STRIP • PLATES
BARS • BILLETS

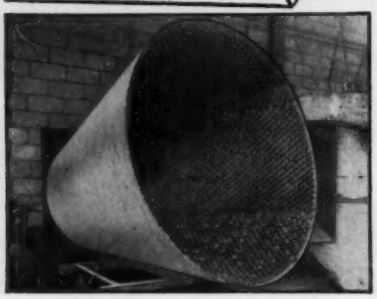
USS

PIPE • TUBES • WIRE
SPECIAL SECTIONS

UNITED STATES STEEL

FEWER "TURN-AROUNDS"





Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

★

"A Fitting Grating for Every Purpose"

IRVICO

IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at
5090 27th St., LONG ISLAND CITY 1, N. Y.
1890 10th St., OAKLAND 23, CALIFORNIA

made, each of the would-be communicants becomes even less receptive to the experiences behind the meanings of the other, and the chances of establishing communication are worse.

Most Americans, for example, are convinced that the correct meaning of the word "democracy" is implied in the nature of American institutions such as the two-party system, private enterprise, and the custom of villifying umpires at baseball games. When the Russian uses the same word to apply to the one-party system, government enterprise, support of independence movements in Asia and Africa and the crushing of similar movements in Eastern Europe, Americans feel that the Russian corrupts the true meaning of democracy, either through ignorance or by design. We feel that democracy is democracy and dictatorship is dictatorship, and that the Russians are befuddling the issues by not calling things by their right names.

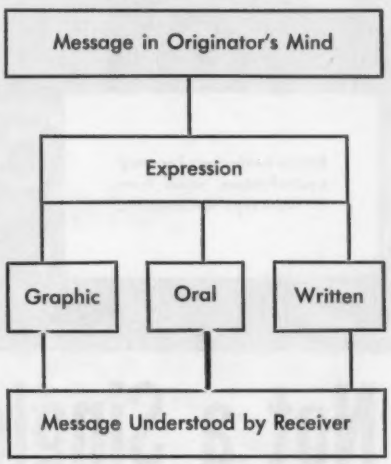
The first principle that becomes apparent to any student of language as a form of human behavior is that there are no right names prescribed by the natural order of things. The relation between names and experience is an arbitrary one, imposed by the people who have experiences and use names to denote them.

The important thing in communication is for the communicants to use the same names for approximately the same experiences (no two experiences are exactly alike). The agreement on what names to use is a small matter. If it makes you understand me better, I am willing to call dogs cats and cats dogs. The difficulty is in acquiring and sharing similar experiences.

The entire communication problem revolves around the experiences of the communicants. The problem of saying what you mean has no other meaning. You can be as precise as you like in your choice of words, follow the most august authorities and consult the most unabridged dictionaries. You can make your speech formal or chatty, erudite or folksy, polysyllabic or monosyllabic, bristling with technical terms or on the level of the *Reader's Digest*. Your success in communicating depends on none of these gimmicks unless you have succeeded somehow in tapping the range of experience of your communicant.

It is useless to "say what you mean," unless by doing so you can impart your meaning to your communicant. Sometimes this happens of its own accord, because the other needs your experience. In that case, he will do the whole work of reaching you, of ferreting your meaning from you. But this is not where communication difficulties are typical. Communication difficulties arise when all you want to do is impart your meaning to the other, and all he wants to do is to impart his meaning to you. Both want to "communicate to." Neither wants to "be communicated to."

COMMUNICATION

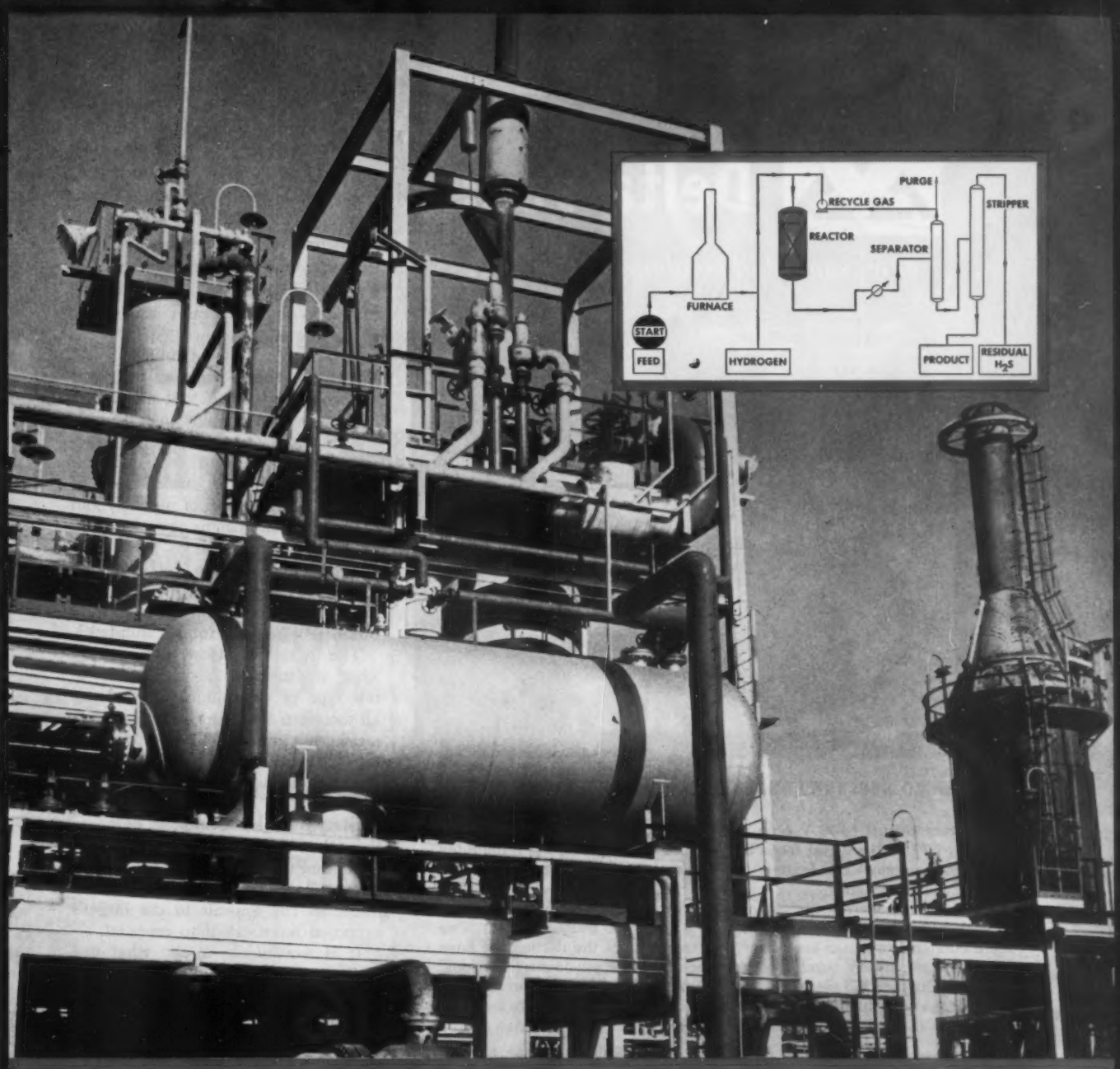


A graphic definition of communication. Effectiveness of communication may be increased by the coordination of graphic, oral and written expression.

It is possible to break this deadlock, simply by giving in, by becoming an active listener. If this change of role is reciprocated (most acts between human beings are reciprocated, both good and bad), communication becomes less of a "talking to" and more of a "talking with." By and large, it is safe to say that people who feel most inadequate in imparting their meaning to others are precisely those who never try to get others' meanings imparted to them.

No less important than the ability to listen (that is, to reproduce in one's self the other's experience) is the ability to gear one's own communication to the experiences of the other. This staying within the range of the other's understanding or interest requires constant checking,

For more data on advertised products, use Readers' Service Cards, last page.



19,500 B/D CRACKED HEATING OIL HYDROFINER, ESSO STANDARD'S BAYWAY REFINERY, LINDEN, N. J.

HYDROFINING CAN GIVE YOU TOP PERFORMANCE AT LOWEST INVESTMENT

Esso Research and Engineering offers you *Hydrofining*, a process now being applied to a greater variety of feed than any other hydrogen-treating process. *Hydrofining* uses by-product hydrogen to remove sulfur and other impurities *without yield loss*.

The process improves product stability, odor, color and other quality characteristics without the disadvantages of chemical or clay treating methods. *Hydrofining* is another achievement of the Esso Research program — 38 years of new process developments made available to refiners around the world.

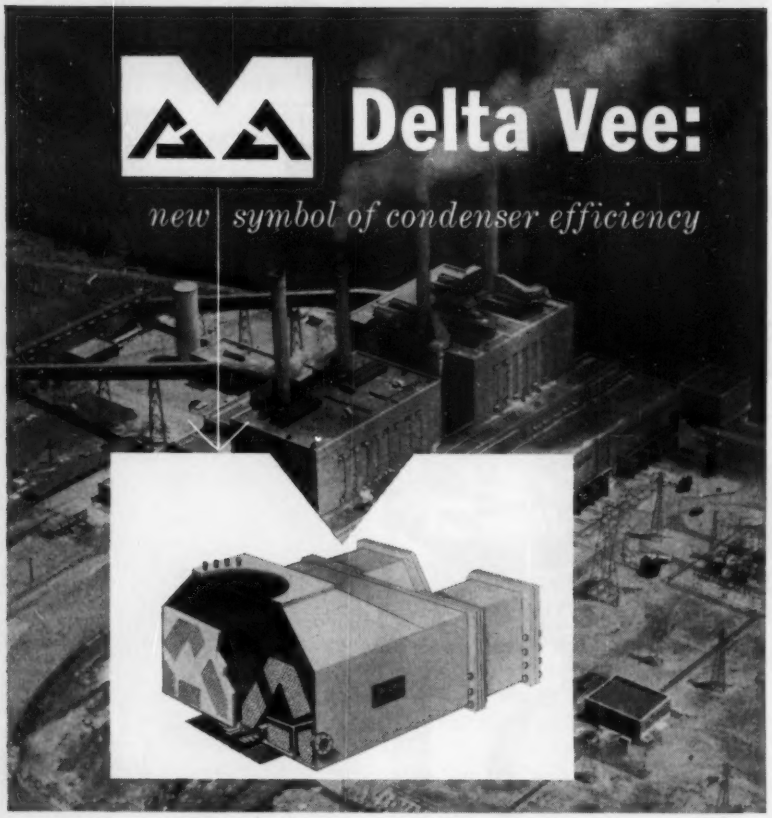
Hydrofining experience has been gained from commercial units processing a wide variety of feed stocks such as naphthas, distillate fuels, lubes and waxes. This experience plus years of hydrogenation research gives us a unique opportunity to recommend the best design for your plant.

Twenty-three *Hydrofining* installations are on stream; eight more are in the construction or planning stage. Licensees enjoy benefits of continuing *Hydrofining* research. *Hydrofining* can play an important part in helping you process previously unattractive stocks into higher quality products. We would welcome your inquiry.

ESSO RESEARCH AND ENGINEERING COMPANY

15 West 51st Street, New York 19, N. Y.

Your key to progress... an Esso Research process



ONLY SWECO SURFACE CONDENSERS OFFER DELTA VEE DESIGN

The water circuit uses V-type water boxes and reversing chamber. Roughly 60% of the water feeds the main banks of tubes; the remainder feeds the secondary condensing sections and air-cooling sections at the sides of the water box.

The condensing circuit is in two delta-shaped tube bundles, one group in each half of the condenser. The two groups are mirror images. The main condensing banks are formed by the arms of the deltas; the base forms the secondary condensing sections and the air-cooling sections.

SWECO Surface Condensers are designed for prime mover service with large steam turbines. Available in sizes from 3,500 square feet and up, SWECO Surface Condensers offer these design advantages:

maximum de-aeration—from large contact-tube areas, positive steam-vented hot well.

even distribution of steam—generous admission area to tube bank reduces water and vapor pressure drop.

increased efficiency of heat transfer—condensate forming on upper tubes flows over minimum number of lower tubes, eliminating water blanketing.

compact installation—low headroom minimizes excavation or structure necessary to set condenser below turbine.

accessible for servicing—end covers are removable, divided water box permits one side of condenser to operate while the other is being cleaned or serviced. (Similar construction is available in non-divided water box design.)

SWECO enters the surface condenser and ejector field with more than forty years experience in the production of pressure vessels and heat exchangers...in thermal and mechanical design...and with complete manufacturing facilities.

Construction, operation and features of SWECO Surface Condensers are described and illustrated in brochure M-3-333. Write for your copy today.

SWECO

Southwestern Engineering Company
4800 Santa Fe Avenue, Los Angeles 58, California
Engineers and Constructors...Manufacturers

partly maintained by listening interspersed with talking (what is now called "feedback" in communication science), partly by a constant examination of one's own communication process.

There are certain questions you can ask yourself while trying to communicate, which in the answering may help you get greater insight into the communication problem:

What is the Purpose of Your Communication? A vast amount of communication has one purpose only—to manipulate behavior toward specific, pre-conceived ends. The explicit and implied exhortations of consumer advertising, of publicity and of political campaigns are examples. The ultimate purpose of these communications is always the same: to get the "targets" to perform some simple act, for example to buy a product or to vote for a candidate.

The question "How can we say what we mean?" hardly applies to this type of communication, because all too often the real meaning of such messages is anything but acceptable to the "targets." Interest in the receiver of such communication is limited strictly to his potentiality as a customer, voter, loyal employe, etc., so that the "success" of this type of communication depends rather on how well this meaning (attitude) is disguised (by appeals to the target's supposed interests) than revealed.

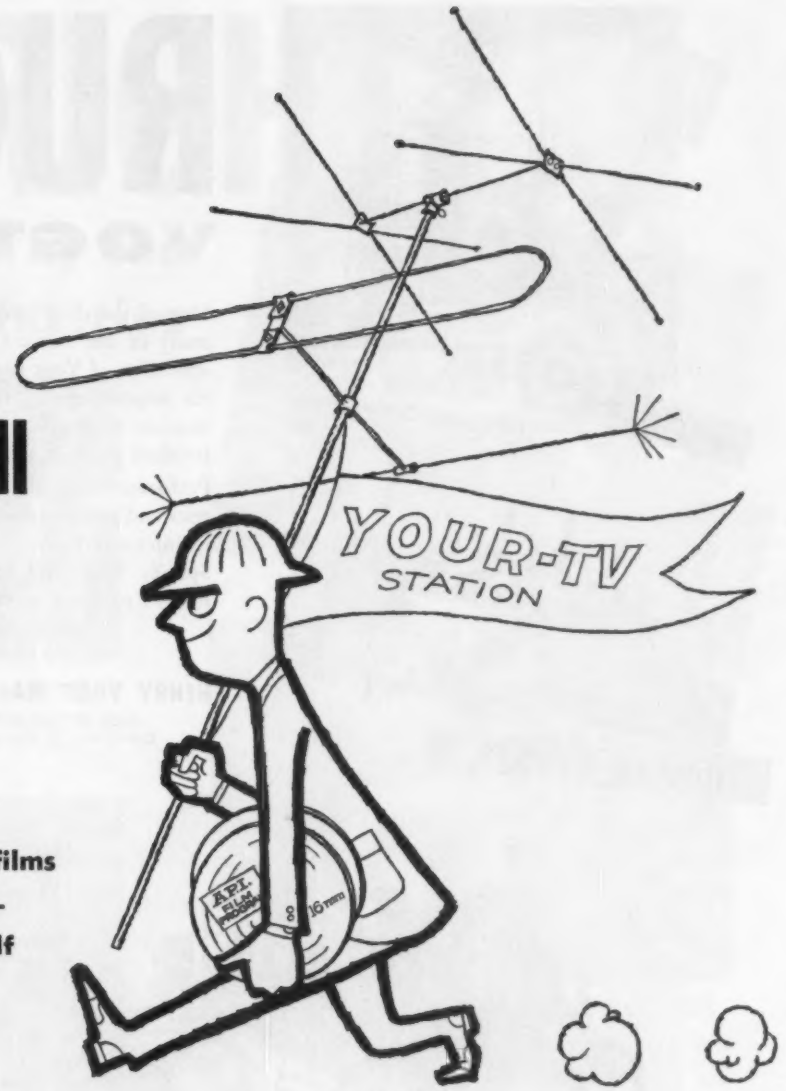
It is worthwhile to say what one really means only in genuinely informative communication, that is, communication whose purpose is to share actual experience. This experience may include views and convictions as well as information, and the purpose of the communication may be to convince and convert as well as to inform. However, it is the sharing of the experience, not the manipulation of gross behavior which is central.

If then, the purpose of a communication is truly informative (including the sharing of attitudes, views and convictions), the crucial step is to find areas of experience already shared and to try to enlarge them so as to include the experience to be communicated.

What is the Level of Your Communication? Several such levels are recognized. There is a level of pure

For more data on advertised products, use Readers' Service Cards, last page.

Now you can help tell oil's story on TV!



Bring "PROGRESS PARADE" films to your local TV station—build prestige for yourself and your industry!

The Oil Information Committee is producing a series of special TV programs about the oil industry called "PROGRESS PARADE." Each program takes the viewer "behind the scenes" to show him this vital industry is working in his best interests. All phases of the industry are covered—and because the programs are informational in nature, stations are glad to telecast them in the public interest—without commercials.

"PROGRESS PARADE" offers you an excellent opportunity to participate in your industry's public relations program and to tell your neighbors how petroleum helps make their everyday lives more enjoyable, more worthwhile.

The Program Manager of your local TV station is constantly looking for new program features and will be happy to receive these specially prepared 13½-minute films. Four different TV films are issued every year.

How to get "PROGRESS PARADE" television films

First check if the TV station in your community has the latest "PROGRESS PARADE" film. If not, just get in touch with your local Oil Information Committee. They will provide you with the most current "PROGRESS PARADE"—and any additional information you'll need.

Don't miss this opportunity to tell *your* story—the oil story—on television. You'll be helping yourself, your company and your industry all at the same time!

American Petroleum Institute
50 W. 50th St., New York 20, N. Y.

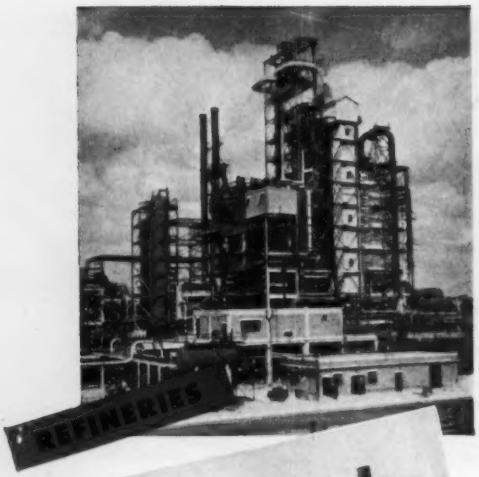
I would like to have the "PROGRESS PARADE" films televised in my community. Please send me the address of my nearest Oil Information Committee District Office.

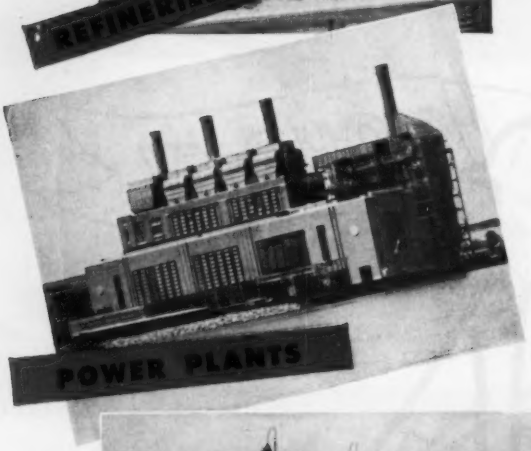
NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

For more data on advertised products, use Readers' Service Cards, last page.





RUGGED

VOGT equipment is

One of the chief reasons why Vogt equipment is used by so many of the nation's key industries is the close working co-operation of Vogt engineers with the customer in determining his requirements. The result is an extraordinary ability to produce mechanical designs which, when translated into the finished product, most economically meet the required needs.

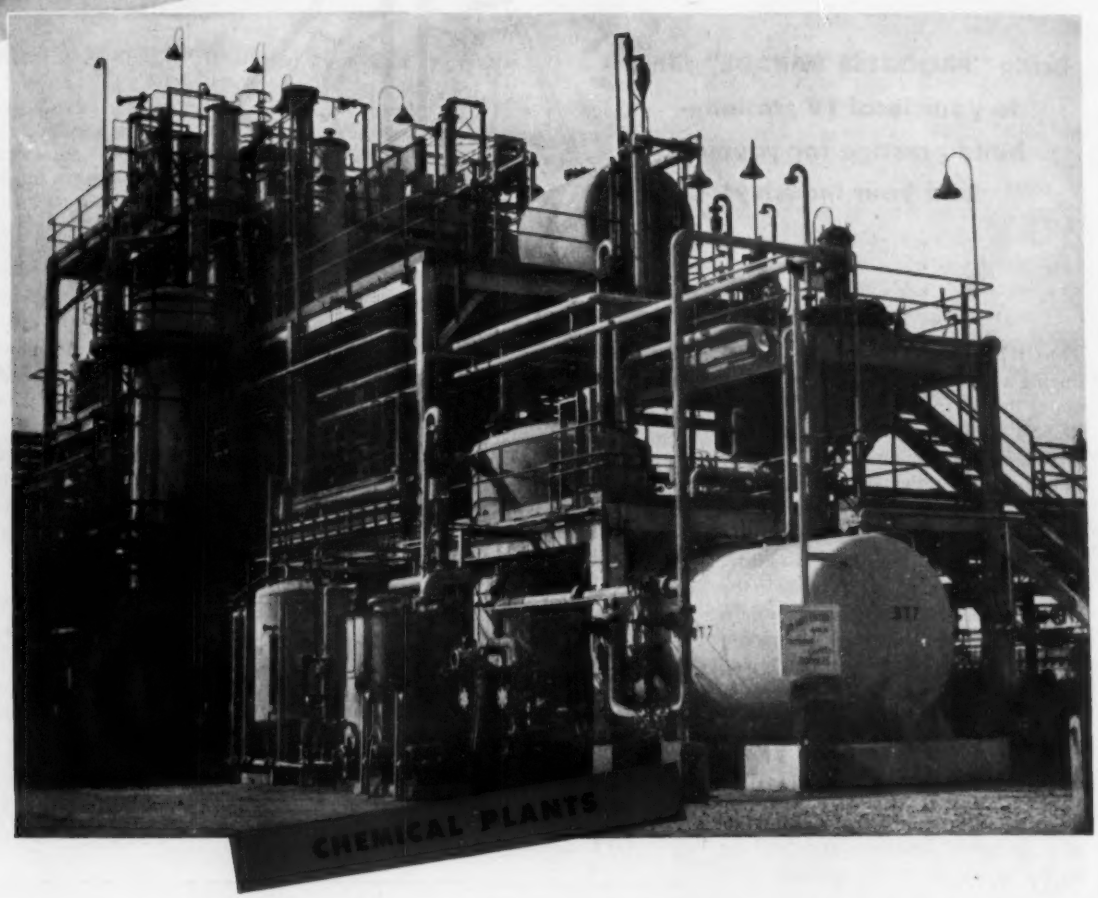
Performance on the job proves, too, that the care and rigid tests and inspections given every Vogt product pay off in low maintenance costs.

Specify Vogt and be sure of equipment which will meet today's toughest service demands.

Write Dept. 24A-GPR for catalogs

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

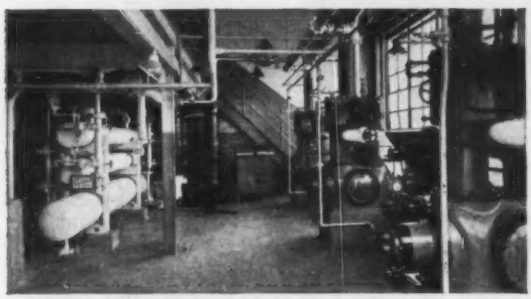
SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO,
CLEVELAND, ST. LOUIS, DALLAS, CINCINNATI, CHARLESTON, W. VA.



For more data on advertised products, use Readers' Service Cards, last page.

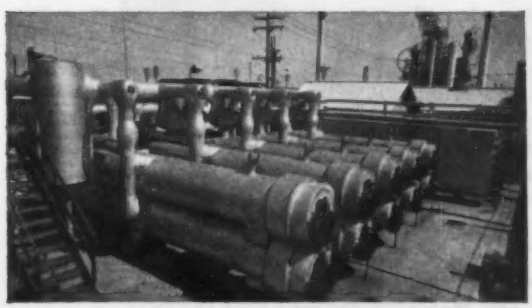
and RIGHT!

used and trusted by the nation's key industries



REFRIGERATION AND ICE MAKING EQUIPMENT

Widely employed in industry for important process work. Compression refrigeration systems, also Tube-Ice units, are available in a wide range of capacities.

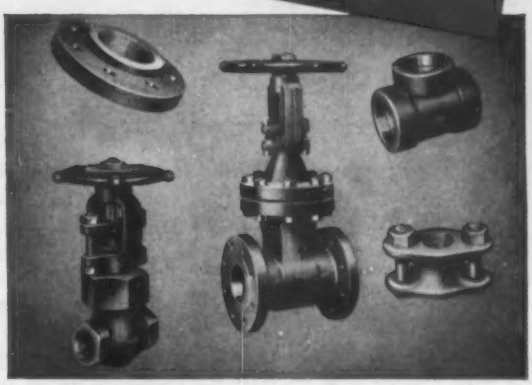


PROCESS EQUIPMENT FOR EVERY SERVICE

Constructed in wide variety to meet all Code requirements. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, high octane gasoline, synthetic rubber, chemicals and related products.

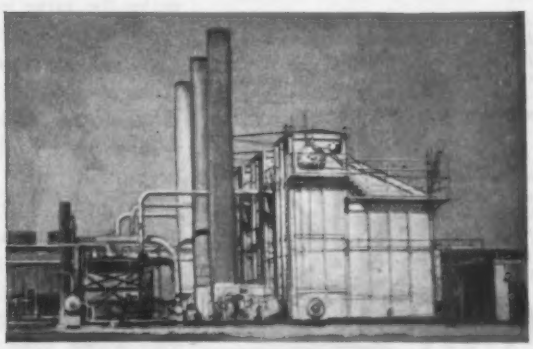
SPECIAL CORROSION RESISTANT MATERIALS

Vogt produces a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Corrosion resistant properties of welds match that of the materials used to construct the equipment.



DROP FORGED VALVES, FITTINGS AND FLANGES

Vogt valves, fittings and flanges are drop forged from carbon and alloy steels to safely handle liquids and gases at high pressures, and high temperatures. Complete line includes: flanged, screwed and socket weld end globe, gate and check valves. Also ells, tees and crosses—couplings—bushings—plugs—unions—flanges and flange unions, and welding heads.

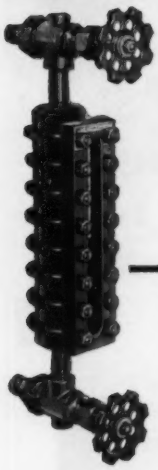


MODERN STEAM GENERATORS

Custom built and package type Vogt steam generators give maximum rating in a minimum of space with high efficiency and low maintenance costs. Available in bent tube and straight tube designs for solid, liquid or gaseous fuels, burned singly or in combination to meet every power, processing or heating requirement.

For more data on advertised products, use Readers' Service Cards, last page.

Get the LEVEL READINGS of LIQUIDS THAT BOIL and Flash



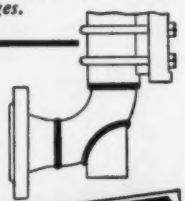
Jerguson Large Chamber Gage

The Jerguson Large Chamber Gage is designed to indicate the level of liquids whose tendency to boil and flash makes an accurate level reading impossible with ordinary gages.

The chamber of this Jerguson Gage is of such large diameter that the level is not badly upset by boiling action of the fluid. This makes possible close level readings, the kind you want and need for accurate control and safety.

You don't have to be satisfied with gages that require guessing at level readings. If liquids boil, install Jerguson Large Chamber Gages and be sure of the liquid level.

The Jerguson Large Chamber Gage is available in reflex and transparent types. Write for full information on this and other Jerguson Gages.



Tapped ¾" pipe threads standard. Available with 2" flanged ends for direct connection to vessel.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.

Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

reporting, descriptions of facts, things, or events, which can be directly verified.

There is a level of *inference,* statements which are not results of direct observation but which are deduced from observations.

There is a level of *judgment,* statements containing implications of right and wrong.

There is a level of *directive* statements suggesting, asking or demanding action.

The question, "What is the level of the communication?" serves to make us aware of what we are actually trying to communicate, a piece of information, an opinion, an attitude, a request or a command. It should be easy enough to distinguish between these "modes," but often the level of the communication is obscured by the words in which it is couched. Since the level is part of the meaning, it is important to keep the communicant informed of the level at which the communication is meant.

Are the Verifiable Facts or Descriptions You Are Reporting Accessible to the Communicant? Must he take your word for them, can he check them directly or in some other way? Any of these supporting suggestions is permissible in proper circumstances, but it is a good idea to make clear on what basis the communicant is to believe your factual story.

Do You Label Your Inferences and Indicate Your Reasons for Making Them? If you take for granted that any one in his right mind would make the same inferences you make, those who do not wish to make the same inferences will tend to blame not their own logic but yours. If you disguise your inferences as facts, those who disagree will think you are ignoring the truth.

To guard against the breakdown of communications at this point, it is a good idea to make clear where the factual story ends and where the inferences begin together with the reasons which have led to your inferences. In this way, the communicant is not intimidated to make the same inferences but merely invited to examine your point of view. Still better is to present clearly and fairly an alternative course of reasoning leading to other inferences (say, an opponent's) together with your reasons for preferring your own.

Do You Label Your Judgments? A judgment is based on a set of values. If you simply take your own set for granted or endow it with superior moral worth, you are in effect telling your communicant (who may operate under a different set of values) that unless he accepts your values, he is morally inferior. Since attitudes tend to be reciprocated, the communicant will usually feel that it is you, not he, who is morally inferior.

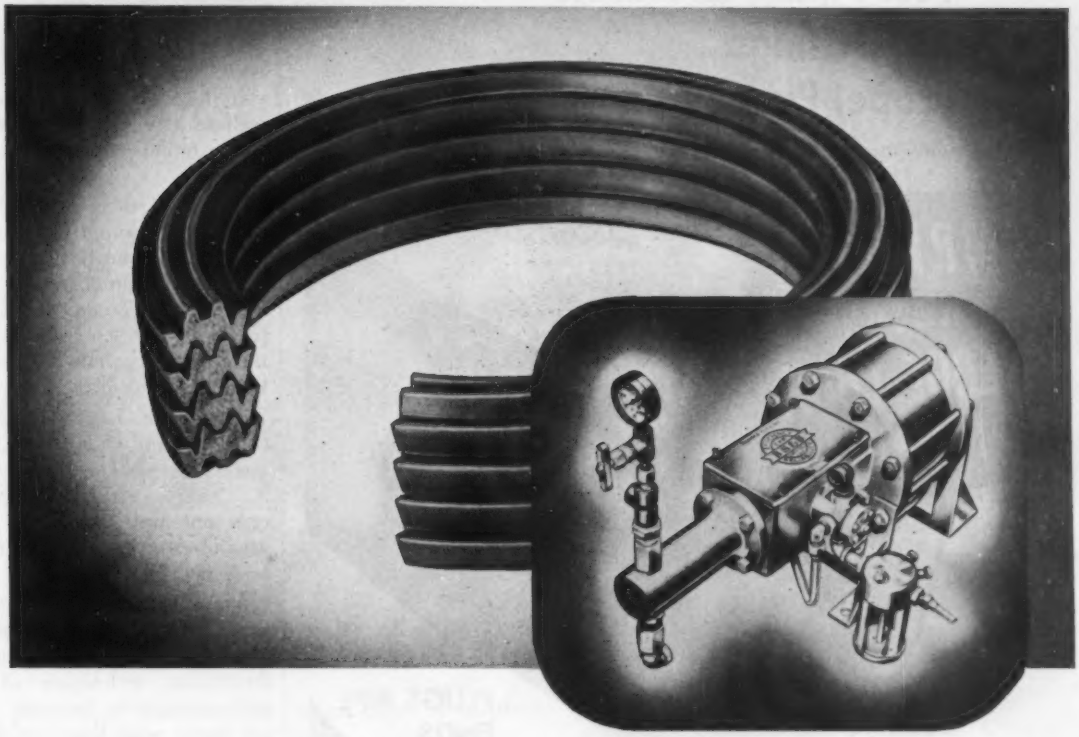
There is not much incentive to share experiences with morally inferior people. That is not to say that moral considerations should be excluded from communication. All of us have moral convictions and feel strong pressures to communicate these convictions to others. If, however, you wish to be sure that the channels of communication remain open (and nothing is so deadly to communication as an argument about what is moral), you must make clear that your judgments are based on a particular, clearly labeled set of values. You must make these explicit and present them as yours, not as something universal and undeniable.

Awareness of alternative convictions and the recognition of their legitimancy, as, for example, when they are derived from another set of experiences, will stimulate such awareness in others, and your convictions will become less preposterous to those who do not share them. Meaning is less likely to be obscured by moral indignation in you or in your communicant.

Do You Bolster Your Directives by Reasons Which Make Sense to Those Who are to Carry Out the Directives? If your communication is to achieve not simply compliance (which is all that despots and children having tantrums are interested in), but a compliance based on understanding, you must dispel any possible notion that your directives are nothing but a show of authority or caprice. To do this it is necessary to show that compliance is of some benefit to you or to your communicant or to some larger unit. You must, of

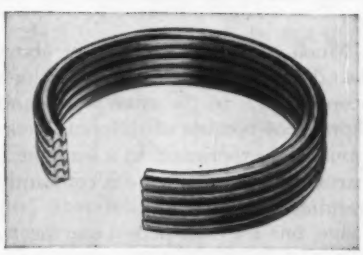
For more data on advertised products, use Readers' Service Cards, last page.

J-M Uneepac® does it again!



"Very satisfactory sealing service against wide variety of fluids and pressures up to 5,500 psi"

says Black, Sivalls and Bryson, Inc. makers of BS&B Glycol Pump



Uneepac comes in two types. Shown here is design for flange widths up to ½" which is used in BS&B Glycol Pump. Large illustration above shows design for flange widths over ½".

Chalk up another success story for Uneepac—Johns-Manville's automatic ring packing. In the BS&B Glycol Pump, fluids handled include triethylene glycol, diethylene glycol, gasoline, and various types of oils, alcohols and petroleum treating chemicals. Working pressures range from 125 psi to 5,500 psi with average operating pressures at 3,000 psi. Yet despite these rugged service conditions, Uneepac has delivered—in Black, Sivalls and Bryson's own words—"very satisfactory service."

Many other packing users have acclaimed J-M Uneepac for its long, trouble-free service. Each ring is a complete packing unit. Fewer rings are needed than ordinarily required and stuffing box size can be reduced to the minimum. Each ring centers itself automatically on the preceding ring to simplify installation. This exclusive design also permits fluid pressure to act upon each lip individually and protects lips from excessive gland pressure.

J-M Uneepac comes in a wide range of styles and sizes for many rod and plunger applications. For further information write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

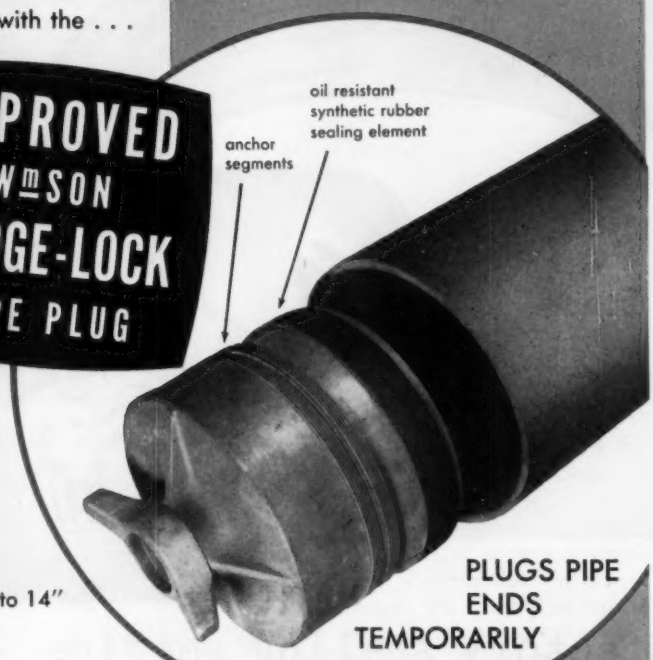
JM PRODUCTS

It's easy to ...

- **Test Piping & Vessels**
- **Add Fittings**
- **Propel Pigs by Compressed Air**

with the . . .

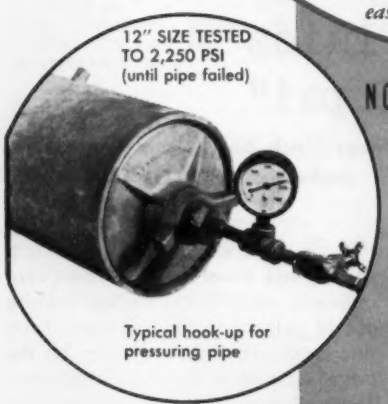
IMPROVED WmSON WEDGE-LOCK PIPE PLUG



Sizes: 3" to 14"

PLUGS PIPE ENDS TEMPORARILY

easily installed & removed



Typical hook-up for pressuring pipe

NOTE THESE IMPROVEMENTS:

- ★ Each size seals in greater range of pipe ID's
- ★ Independent anchor segments insure uniform grip inside pipe
- ★ Large bypass hole through center
- ★ Rugged sealing element
- ★ Permanent dry film lubrication

Write for Bulletin and pressure ratings

T.D.Williamson, Inc.

P. O. BOX 4038 TULSA 9, OKLAHOMA

REPRESENTATIVES: HOUSTON · AMARILLO · PITTSBURGH · PLAINFIELD, N. J. · JOLIET, ILL. · JACKSON, MICH. · LOS ANGELES · SAN FRANCISCO BARTLESVILLE, OKLA. · SEATTLE · EDMONTON · TORONTO · CALGARY VANCOUVER · BUENOS AIRES · CABIMAS, ZULIA, VENEZUELA · DURBAN, NATAL, SOUTH AFRICA · PARIS, FRANCE · SIDNEY, AUSTRALIA

course, show why this is so and in the process leave no doubt about what is fact, what inference, and what judgment.

If what you are asking benefits primarily you, you must say so. You have a right to ask favors or services from others (who have similar claims on you). There is no need to disguise these requests to make it appear that you have only the communicant's welfare in mind. Such stratagems are easily found out and destroy confidence.

In short, there is one paramount principle of sound communication (called by some people *language hygiene*). Communication is sound if it is a two-way process. It is a two-way process if the communicants stick to their area of common experience and keep enlarging it.

It is the responsibility of each communicant to enlarge the area of his own experience, so that more of it is shared with the other. There is only one way to enlarge one's own area of experience: this is to be somebody else for a while.

You cannot, of course, assume the other's identity, but you can get some idea how it feels to be the other by developing techniques of attentive and sympathetic listening. When you are faced with linguistic differences, this point is so obvious that it hardly needs to be stated. No one has ever learned a foreign language without having his ear accustomed to a set of different (foreign, strange) sounds. No one has ever internalized another language without getting rid of a conviction that there is no right way to speak, that various people have developed various ways of speaking, each pretty nearly as serviceable as the rest.

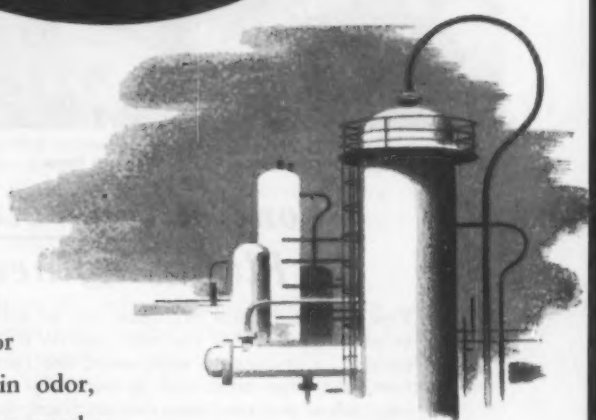
Much has to be learned yet about the differences of meanings which people attach to the same words and expressions because of different backgrounds of experience. In a way, then, learning to communicate is constantly learning a somewhat different language, one for each person one meets.

Only when you have learned to command the language of the other can you hope to be able to "say what you mean," that is, to impart your real inner meaning via an air disturbance or a collection of ink marks, into the sanctum sanctorum of the other's inner self. ##

For more data on advertised products, use Readers' Service Cards, last page.

Versatility is TRADITIONAL at WESTERN

Versatility is important in **TREATING**



Treating petroleum fractions for the removal of sulphur, nitrogen, oxygen and other contaminants is a versatile hydrogenation process.

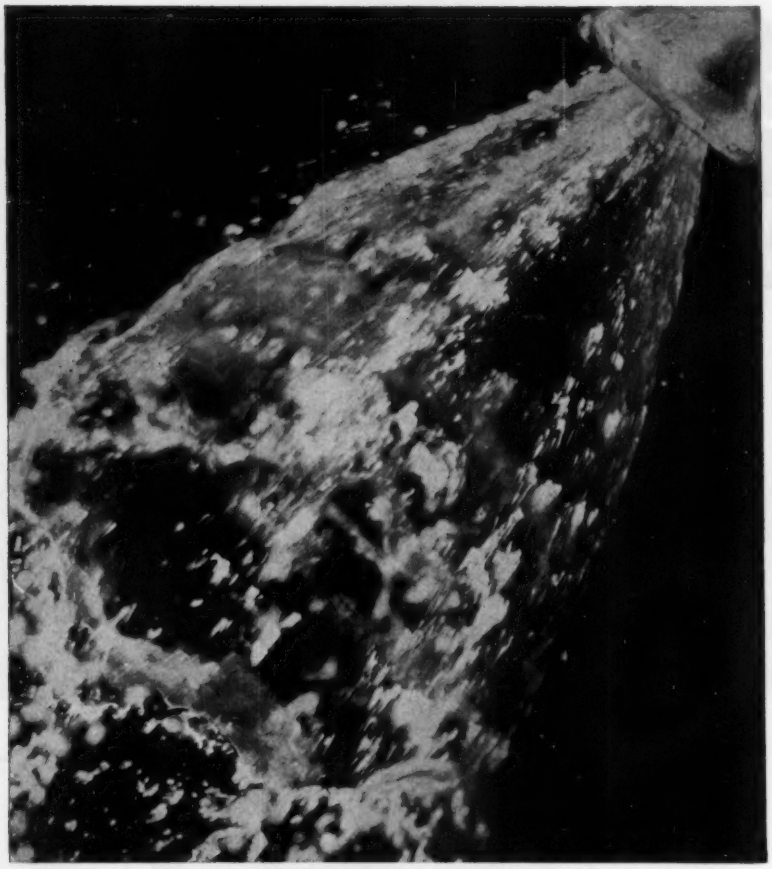
With a range of objectives which includes reduction in sulphur and nitrogen compounds—preparation of straight-run or cracked catalytic reforming feedstocks—improvement in odor, color, gum or storage stability, in burning properties, cetane number, lead susceptibility, and susceptibility to catalytic cracking—the equipment used in these process applications must provide an equal range of versatility.

Western Heat Exchangers are closely rated, carefully designed and accurately fabricated to meet the exacting demands of such treating processes—and merit *your* consideration and acceptance.

Western Heat Exchangers are used extensively and satisfactorily in hydrogen treating.

Western's representatives are at your command—**immediately.**

WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P. O. Box 1888 – Tulsa, Oklahoma



To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

Controlling Volume in Fluid Engineering

Few volume control problems can be solved with a quick twist of your wrist the way you do with a garden hose nozzle. In processing equipment, the factors of pressure, flow, and time must also be carefully considered. That's why, when you need accurate answers, you can depend on the broad engineering background S. Morgan Smith offers.

Take an SMS Rotovalve, for instance. Its full line opening means least head loss, lower pumping costs. Hydraulic imbalance and mechanical design make the Rotovalve easy to operate. Fast initial shut-off limits reversal of flow, and closing can be in one second or as slow as required. Final closure is positive and drop tight throughout valve life. SMS Ball Valves, similar to Rotovalves, offer many of these same advantages.

Information on the complete SMS line – R-S Butterfly Valves, Rotovalves and Ball Valves may be obtained by calling our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special, engineered applications.

S. MORGAN SMITH SMS HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

Streamline Your Workload

Continued from Page 301

The Telephone—the third, and most time-consuming piece of office furniture.

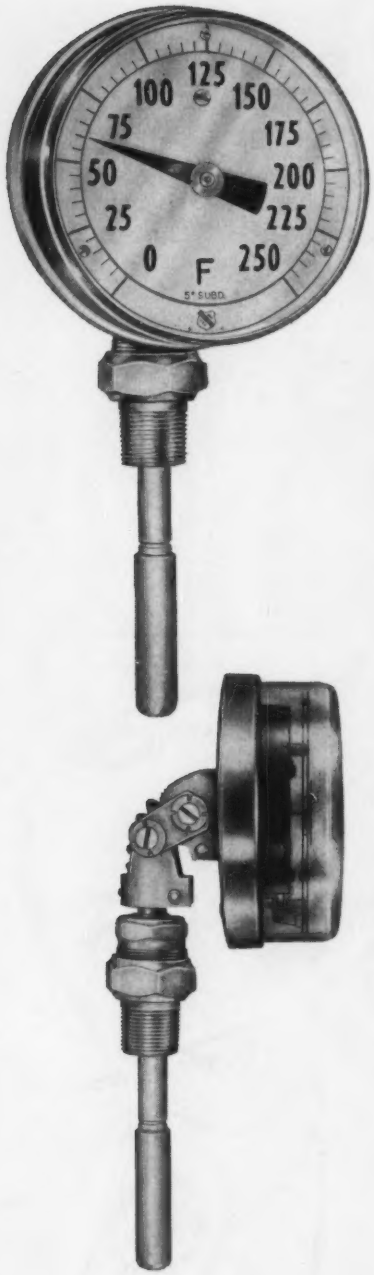
would like to try it from time to time. But we can do business more efficiently by recognizing the danger that's inherent in the time lost every time it rings.

Executives understand the problem created by the interruption feature of the telephone. They might be engaged in creative thinking and then find the telephone calls interrupt and disturb their thought trends. Some executives deal with the pesky problem by shutting off the telephone from time to time. But this is not always practical. The most important thing to bear in mind is that it's so easy to waste time on a telephone and also so easy to make unnecessary calls. That takes time and money.

Let's give a quick example of how the telephone by its very convenience can create unnecessary telephone traffic. One company links its executive offices in Chicago with its operating headquarters in Denver, and its maintenance headquarters in San Francisco, with a direct private telephone line. Recently I placed a call in the early part of the afternoon for one of our officials in Denver and my secretary informed me that there were 18 calls ahead of me, and if I wanted the call completed that day I should make it outside by long distance.

Because I was interested in the subject of streamlining the executive workload I asked the switchboard if, in routine fashion, she would check the supervisors to find out if the purpose of the calls could be served equally well by telegram or even an air mail letter. As a result of that survey 12 out of the 18 calls were

For more data on advertised products, use Readers' Service Cards, last page.



NEW

MERCURY ACTUATION

IN A MODERN 'AMERICAN' "Every Angle" DIAL THERMOMETER

If you expect the most for your money in readability, accuracy and durability, here is the best dial thermometer investment you can make. The 'American' Mercury-Actuated "Every Angle" Dial Thermometer provides a combination of five major advantages found in no other thermometer:

"Every Angle" Set-ability. You can turn the dial to any angle within 180° on two axes. Whether installed above or below eye level — to the right or left of the reading point — you get easy face-to-face readings.

Fast, Accurate Indication. Mercury — one of the most sensitive heat transfer mediums — makes possible readings up to 1000° F. in a few moments with accuracy within 1% of the entire scale range.

Surest, Sharpest, Easiest Readings. The Maxivision® dial — a split-level dial — is constructed so that the graduations and pointer are on the same plane. No perspective effect. No parallax error in reading.

Best in Visibility. The cover is a large, durable, clear glass dome without bezel. No dark shadows dim the dial to hinder reading accuracy.

Stainless Steel Construction. Movement, capillary tubing, stem, case and cover mounting — all are stainless steel.

Where resistance to corrosion is important, where appearance and cleanliness are essential, the 'American' Mercury-Actuated "Every Angle" Dial Thermometer is ideal. It is rugged — has every quality required for the toughest services, indoors and outdoors. From the standpoint of economy, the "Every Angle" feature alone can save money in new piping specifications and when changing existing piping. It reduces the need to re-specify and stock a variety of fixed stem thermometers.

Dial Size: 4½". *Temperature Ranges:* —20/120° F. to 200/1000° F. *Stem Lengths:* 4", 6", 8", 12", 18" and 24". Separable sockets available.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has complete information on the 'American' Mercury-Actuated "Every Angle" Dial Thermometer. Call on him to fulfill your requirements with fast delivery from local stocks.

1850 AMERICAN U.S.A.

AMERICAN INDUSTRIAL INSTRUMENTS

MAXWELL MANNING MM&M MOORE INC. TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn., and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

IT DOESN'T SHOW HERE, BUT...

A Lot of Science

Went Into This Sale!

Everybody in any phase of the petroleum business, production, research, manufacture, marketing, is strongly activated by one vital concern—the profitable sale of an end product to the ultimate consumer. And that's exactly what we are working toward, too.

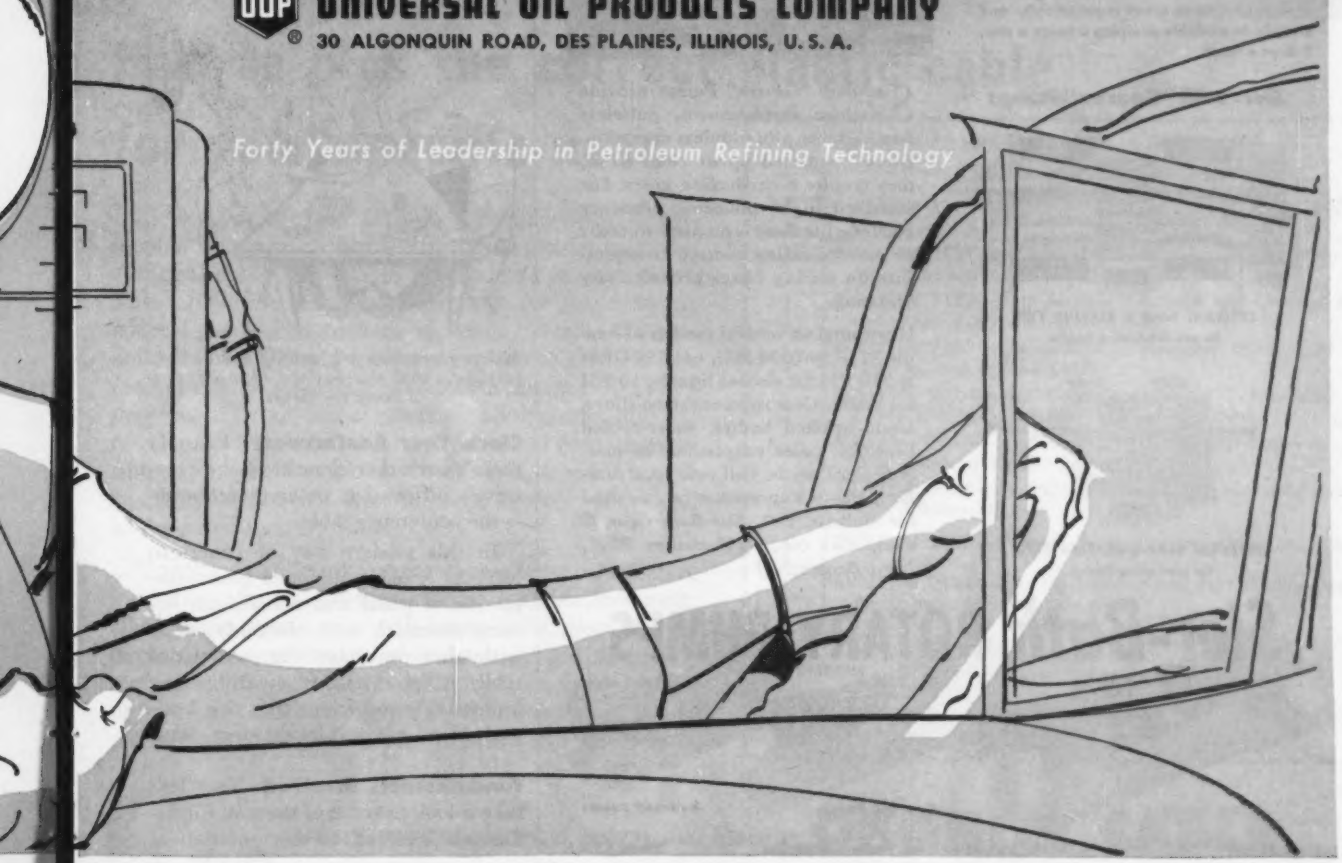
As a research and development organization, UOP and its staff of scientists and engineers constantly apply their efforts and technical talents to the broad task of helping refiners provide the type of product that satisfactorily meets consumer needs at a reasonable cost.

For more than forty years, Universal-developed refining processes and techniques, available to refiners everywhere, have made a major contribution to the industry's ability to offer the motoring public the type of product it will and can buy.

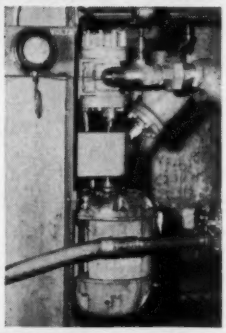
Not only at UOP, but throughout the industry, scientific research and development is being applied to the ultimate end of keeping product quality and cost in salable proportion to consumer demand. That's why we know when some motorist says "Fill it up", that a lot of science has gone into the sale.

UOP® **UNIVERSAL OIL PRODUCTS COMPANY**
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

Forty Years of Leadership in Petroleum Refining Technology



For more data on advertised products, use Readers' Service Cards, last page.

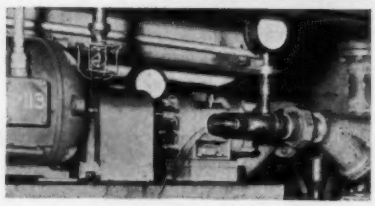


Drum-filling speeded up--wider range handled--costs cut with

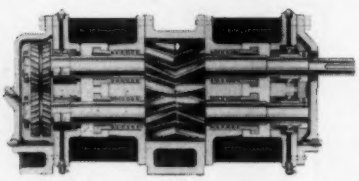
Sier-Bath GEAREX®

ROTARY PUMPS

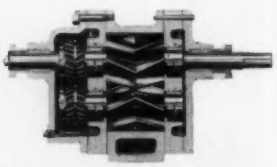
● A midwestern oil company installed a battery of Sier-Bath "Gearex" Pumps to replace the gravity feed method. Feeding capacity is now 90 gpm.—a wider range of viscosities and temperatures is handled—more drums filled per day, at lower cost. Pumps are installed in both vertical and horizontal positions according to space requirements, and provide dependable pumping 8 hours a day, 5 days a week.



***Sier-Bath* "Gearex" Pumps**



EXTERNAL GEAR & BEARING TYPE
for non-lubricating liquids



INTERNAL GEAR & BEARING TYPE
for lubricating liquids

Sier-Bath "Gearex" Pumps provide positive displacement, pulseless flow . . . quiet, vibrationless operation. Direct-connected up to 1800 RPM, they require no reduction gears. For sustained high volumetric efficiency and long life there is no rotor-to-rotor or rotor-to-casing contact. Low pressure on stuffing boxes provides easy servicing.

Horizontal or vertical models to handle 32 to 500,000 SSU, 1 to 550 GPM at 250 PSI for viscous liquids, 50 PSI for water. Corrosion-resistant alloys, steam-jacketed bodies, water-cooled bearings, other adaptations to meet individual needs. Call your local Sier-Bath Pump Representative . . . send for Bulletin G-2. *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

Sier-Bath ROTARY PUMPS

Screw Pumps **Gearex® Pumps** **Hydrex® Pumps**

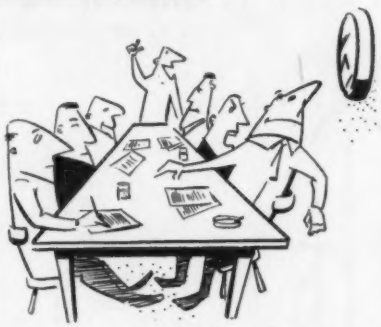
50th Anniversary **Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings** **Member A.G.M.A.**

cancelled. That illustrates the temptation of the telephone.

Discourage Visiting Firemen. The fourth piece of time wasting office equipment is the visitor's chair. That is a very essential piece of any office furniture. If it's not being used, if it's getting dusty then we can become disturbed over our own business progress. But the fact remains, many occupants of the visitor's chair are not sensitive to the value of the time of the gentlemen on whom he is calling.

A book recently published called "How to Gain An Extra Hour Every Day" by Ray Josephs recognizes the problem of inroads on executives' time by people who come in without a concise businesslike presentation of the point of the interview. One of the author's suggestions to deal with that type of situation is to look at the ceiling or out the window occasionally.

The main thing is that if we recognize the attrition in time represented over the year by the visiting firemen, polite as we may be to them, we must then develop a more businesslike desk side manner.



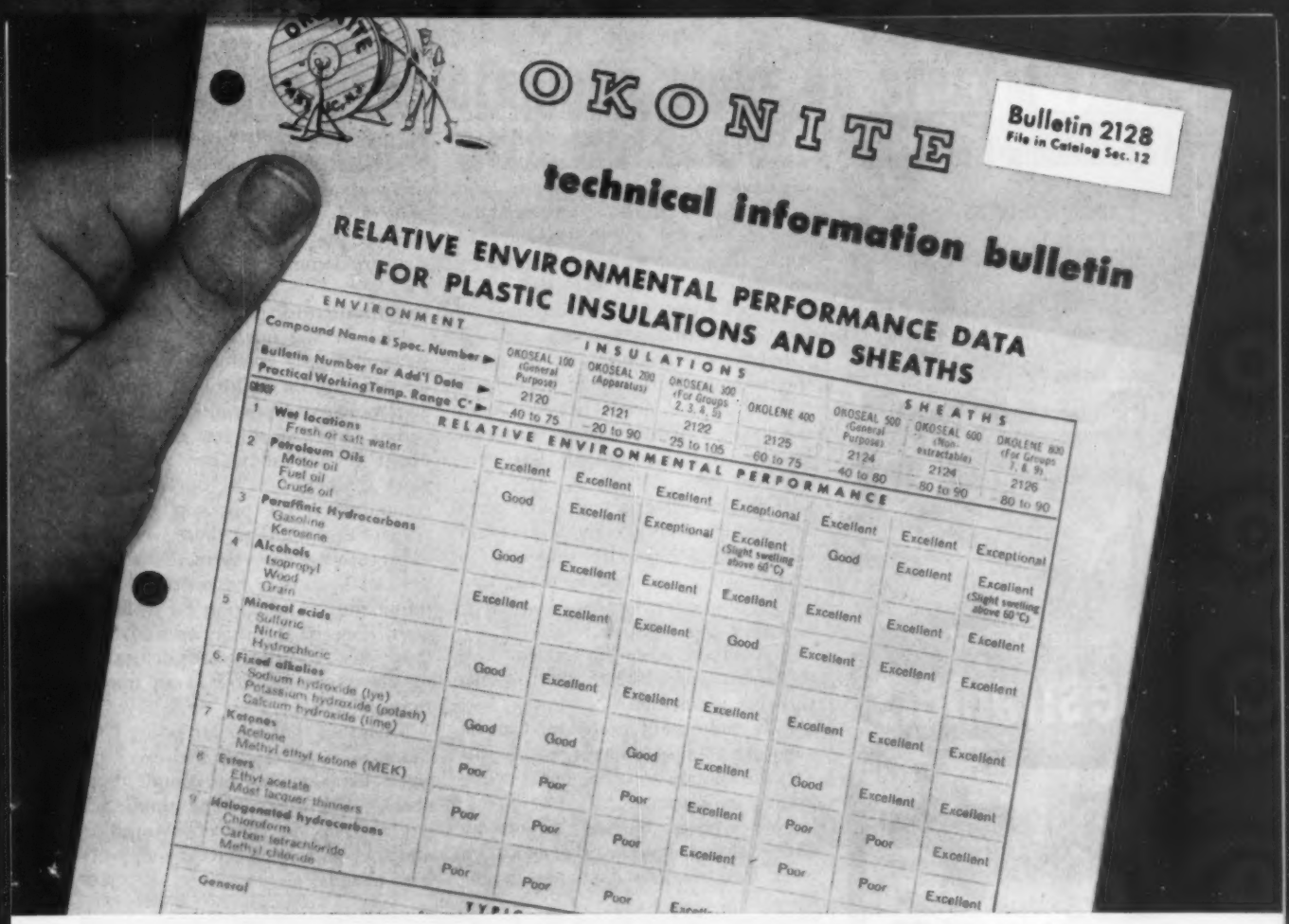
Many executives are getting increasingly suspicious that this business of meetings is being overdone.

Clock Your Conferences. Finally there's one other element of the executive's office that deserves attention —the conference table.

In this modern day of American business a many actioned group discussion of plans and policies has become essential, and obviously along with that we have the conference table. A lot of executives are getting increasingly suspicious that this business of meetings is being over done.

Fundamentals Involved. Now let's take a look at some of the real fundamentals involved in this question of

For more data on advertised products, use Readers' Service Cards, last page.



How to pick the correct plastic cable for your specific need

Bulletins prepared by Okonite's Engineering Department will help you select the optimum plastic-insulated electrical cables for various applications in your plant. These bulletins, compiled especially for the refining, natural gas and petrochemical fields, describe the several available Okoseal (polyvinyl chloride) and Okolene (polyethylene) insulation and sheath compounds. They provide, in detail, the dimensions, applications and the resistance of each to such environmental conditions as salt water, petroleum oils, paraffinic hydrocarbons, alcohols, mineral acids, fixed alkalies, ketones, esters and halogenated hydrocarbons.

Using these bulletins, you can choose the most effective insulation and sheath material for each environment. Okonite can provide you with longer-lived, more reliable circuits for power, control, machine tool, lighting circuit, motor lead, switchboard, communication and cathodic protection. Check and send in this coupon for complete information on Okonite plastic wires and cables.

THE OKONITE COMPANY, Passaic, N. J.
Kindly send me the free bulletins checked below.

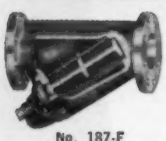
- ☐ **BULLETIN 2120**—Insulated Power and Control Cable—600 Volts (Okoseal 100)
- ☐ **BULLETIN 2121**—Machine Tool and Switchboard Wire—600 Volts (Okoseal 200)
- ☐ **BULLETIN 2122**—High Ambient Petroleum and Chemical Resistant Wire—600 Volts (Okoseal 300)
- ☐ **BULLETIN 2123**—Oil and Gas Resistant Wire—600 Volts (Okoseal-Nylon, Type OGR)
- ☐ **BULLETIN 2124**—Multi-Conductor Control Cable—600 Volts (Okoseal 100)
- ☐ **BULLETIN 2125**—Insulated Power and Control Cable—0-5000 Volts (Okolene 400)
- ☐ **BULLETIN 2126**—Multi-Conductor Control Cable—600 and 1000 Volts (Okolene 400)
- ☐ **BULLETIN 2127**—Cathodic Protection Cable (Okolene 400)
- ☐ **BULLETIN 2128**—Relative Environmental Performance Data for Plastic Insulations and Sheaths

NAME ..... TITLE .....
COMPANY .....
ADDRESS .....
CITY ..... STATE .....

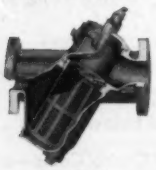
4419

where there's electrical power . . . there's **OKONITE CABLE**

WITH OPW
line strainers


No. 187-F
Bottom opening
type. 125 pound

No. 387
Top outlet type.
125 pound.


No. 387-F
Top outlet type
flanged. 125 pound.

No. 487-F
Top outlet type
flanged. 200 pound.

OPW Line Strainers remove dirt, scale, rust and other solids from liquids flowing in any pipe line system. This positive screening-out process protects and prolongs life of pumps, meters, loading valves, and mechanical equipment. Pipe-snug fit of cage and screen, plus larger than pipe size screen area, assures *free* and *complete* flow of product through strainer. Screens can be quickly and easily removed for periodic check-ups, cleaning and replacement.

Bulletin F-36 gives full details on sizes, styles, screen mesh, etc. Write today.

JORDAN CORPORATION
Division of OPW Corporation
6013 Wiehe Road Cincinnati 13, Ohio
ELmhurst 1-1352

streamlining the executive work load.

First is the very organization in which we work. Even though the organization of one company and another may differ, fundamentally they're tailored to the concept of concentration of policy and authority and decentralization of work.

We all have our organizations, we have our assistants, we have our staff —but we are not using, in all cases, the organizations which have been tailored to our needs, as we should use them. This business of delegation is a much talked about, but very sensitive area.

If an executive is really interested in checking whether an item should be delegated it can be subjected to certain questions such as these:

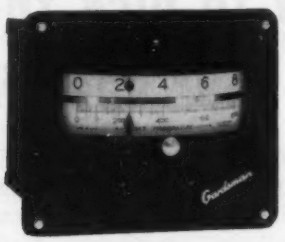
1. Is it a policy item?
2. Is it repetitive or retained?
3. Are there subordinates who have the ability and all the facts to make this type of decision?
4. Is there really a choice? Can he even consider spending time on this area in relation to other items of far greater importance?

One type of business philosophy which always lightens the executive work load requires a change in approach on the executive's part from participating fully in every activity to concentrating on developing measurements which will get across to his people what he expects of them, and then a simple report on how well they are doing.

Communications. Another point involved in this matter of executive streamlining is communications. We all know that a well-informed organization is a more productive organization, but sometimes we forget about it and sometimes we make work for ourselves by our failure to communicate the philosophy of our policies and plans to those whom we expect to execute them. Sometimes we can save time by properly communicating information on what we want done at the time we make the delegation. In other words delegation means communication as an important adjunct.

To insure that you are doing your share in streamlining the executive work load—make this simple little check—"Have you some time each day to relax in your office and get some perspective on the over-all problems ahead?" ##

Step UP
with
Gardsman
MODEL
JP SERIES
PROPORTIONING
TEMPERATURE
CONTROLLER



CONSISTENT
ACCURACY!

This *tube-free* instrument brings many advantages over *any* on-off controller. *Anticipates* temperature change, tends to stabilize at *closer* tolerance. Cuts rejects, maintenance; ends adjustment, tube-replacement. Reliability *Guaranteed.* Write for Bulletin JP-1.

4357B West Montrose Ave.
Chicago 41, Illinois

WEST Instrument
CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

LESS MECHANICAL CLEANING, MORE ON STREAM TIME WITH UNITS TUBED WITH WOLVERINE TRUFIN® TYPE S/T

Concentration Unit Still On Stream After Two Years

With the passing of each day more and more evidence is accumulating to prove – very conclusively – that condensers and heat exchangers tubed with integrally finned condenser tube stay on stream for longer periods than those using plain tube.

Illustrated at the top right, for example, is the flow sheet of a gas concentration unit at a large midwest refinery. Five of its heat exchangers are tubed with Wolverine Trufin Type S/T–the integrally finned condenser tube. These units consist of a debutanizer bottom cooler, debutanizer overhead condenser (2 exchangers in parallel) and a high pressure cooler (2 exchangers in series).

WOLVERINE TRUFIN

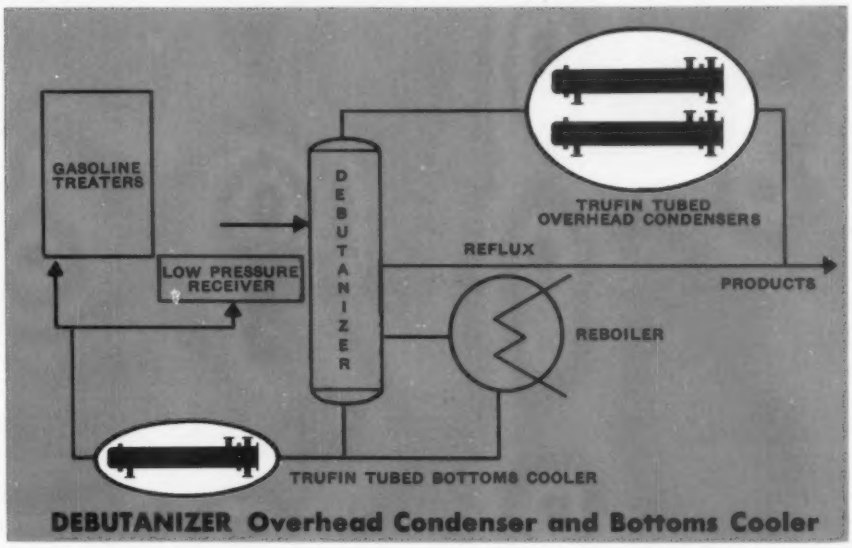
The units (tubed with Trufin Type S/T, ¾" O.D., 16 BWG admiralty brass condenser tubes), have been on stream for two full years without requiring mechanical cleaning on the shell side–and are still going strong.

In establishing the reasons for this resistance to fouling, engineers have discovered that the configuration of Trufin surface is apparently less conducive to scale build-up than bare tube. Scaling tends to follow the contour of the fins and does not accumulate preferentially between the fins but forms an extended projection of the fin. In many cases the tubes appear to be self shedding.

GET VALUABLE BOOK FREE

Detailed breakdowns in cost differentials between prime surface and integrally finned condenser tubes are graphically explained in Wolverine's new book "Comparative Heat Exchanger Costs".

Just off the press, this new book will be invaluable to design and processing engineers alike. It carries complete cost comparisons for the design of new heat exchangers and condensers as well as for the retubing of existing equipment. Write for your FREE copy.



DEBUTANIZER Overhead Condenser and Bottoms Cooler

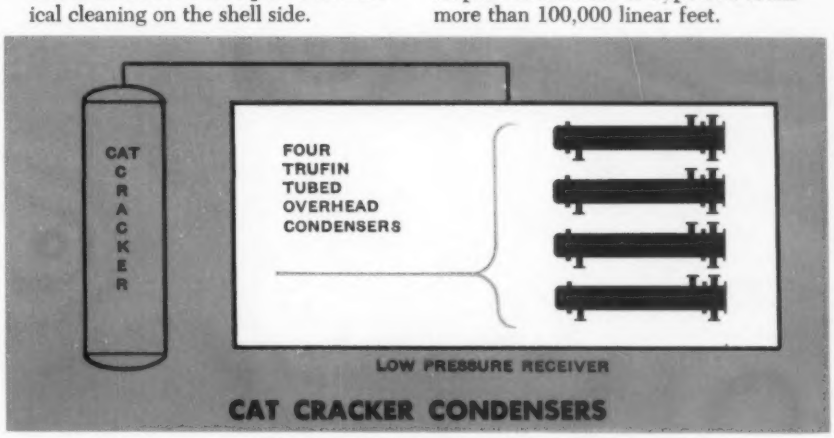
Trufin-Tubed Units For Cat Cracker Still Going Strong After Three Years

Still another authenticated example of outstanding performance by Wolverine Trufin Type S/T is found in the catalytic cracking unit of this same refinery.

This operation consists of four Trufin-tubed heat exchangers used in condensing-subcooling service for taking overhead vapors from the "cat" crackers. These exchangers have been on stream continuously for three years and to date have not required mechanical cleaning on the shell side.

In addition to increasing on stream time, Wolverine Trufin Type S/T also boosts heat transfer performance. Because of its extended surface, Type S/T has approximately 2½ times more surface area than does plain tube. The result is more BTU's extracted per foot of tube.

It is because of such features, for example, that the engineers in this particular refinery specify Wolverine Trufin Type S/T whenever possible. At present their use of Type S/T totals more than 100,000 linear feet.



CAT CRACKER CONDENSERS

Wolverine Trufin is available in Canada, through the Unifin Tube Company, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1437 CENTRAL AVE., DETROIT 9, MICH.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Plants in Detroit, Michigan, and Decatur, Alabama. Sales Offices in Principal Cities
EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.

TUBEMANSHIP:
Means Top-Flight Condenser Tubing for Chemical and Petroleum Industries

By Ernest Dodd

Have you ever visited a modern tube mill—such as either of those operated by Wolverine Tube in Detroit, Michigan or Decatur, Alabama? It's quite an experience to see piercing mills, extrusion presses and giant draw benches producing gleaming aluminum and copper tube.

It's quite an experience also to talk to Wolverine employees – from the top brass in the front offices to the men that man the machines. It isn't long before you realize that here are men with great pride and single purpose in their work. You begin to recognize a certain something that they all have in common.

You discover that this mysterious "something" has a different meaning to everyone with whom you speak. To the setup man, for example, it's the delicate touch with which he adjusts a machine, while an inspector will tell you that its the care with which he examines finished tube before releasing it to the customer.

The sales group will tell you it's the completeness of the product line while a plant manager will say that it's made up of facilities . . . things like plants and machines and manufacturing processes.

And, as you talk to all these people, something suddenly clicks . . . becomes crystal clear. You know what a Wolverine man or woman means when they mention "Tubemanship". It's a word that can be described differently by different people—yet have the same meaning to all.

Actually it's the same individual pride – deep within its people – that has made America and American industry great. At Wolverine they call it Tubemanship. It is your assurance of the finest tubing it is possible to make.

WOLVERINE HAS COMPLETE CONDENSER TUBE LINEUP

Processing engineers can specify Wolverine condenser tubing to meet every type of operating condition.

Wolverine prime surface tube, for example, is available in a wide range of sizes and alloys in both copper, copper base alloys and aluminum. If increased heat transfer capacity is a must, engineers can specify Wolverine Trufin®—the integrally finned condenser tube. Trufin is available in five distinct types with various fin spacings and heights. Depending on type, it can be specified in many sizes and alloys in copper, copper-base alloys, aluminum and electric-welded steel.

Where corrosion on both sides is encountered, Wolverine Duplex, in either integrally finned or prime surface form, can be specified. To speed retubing operations and reduce condenser tube inventories, Wolverine U-bend condenser tubes are recommended. These prefabricated condenser tubes are shipped in the exact order of their installation in disposable, box-type pallets.

FREE ENGINEERING HELP

Ready at all times to help customers solve tubing problems are the highly skilled members of Wolverine's Field Engineering Service. These tubing technicians will come up with the right answers to such tubing and heat transfer problems as corrosion, design, applications, etc. Next time you have a tubing problem – don't hesitate – ask for the services of a Wolverine Field Engineer.

WRITE FOR THIS NEW BOOK

The story of Wolverine Tube – its employees, facilities and products is graphically told in Wolverine's newest book "The Measure of Tubemanship". Write today for your free copy.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1437 CENTRAL AVE., DETROIT 9, MICH.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Plants in Detroit, Michigan, and Decatur, Alabama. Sales Offices in Principal Cities

EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

"If Oil Could Speak" it would tell the American public:

•

- To fill a medium-sized oil tank ship would require the liquid cargo of nearly eight hundred of the big clipper trucks that haul oil on highways and at airports.

•

- One large steel-producing company burns enough petroleum fuel in one year to heat a five-room house for 380 centuries!

•

- Petroleum and its products make up the largest category of barge shipments, followed in order by coal, sulfur, chemicals, iron and steel, sand and gravel, and grain.

•

- The service station is one of the greatest points of sale in America today—more than 12 billion dollars' worth of high-quality products flow through these "islands" every year.

•

- The energy obtained yearly from crude oil and natural gas is the equivalent of the work of 33 servants for every man, woman, and child in the nation.

•

- A recent survey of 33,537 irrigation wells in the high plains area of Texas shows that 46 percent use liquefied petroleum gas, 35 percent run with natural gas, and the remainder operate with gasoline, diesel fuel, or electricity.

•

- One out of every four floor furnaces sold in America last year was built to operate on liquefied petroleum gas.

•

- The six busiest airports in the United States are paved with petroleum asphalt. Ranked according to volume of operations, they are: Chicago's Midway, New York's La Guardia, Washington's National, Los Angeles, San Francisco, and Miami.

•

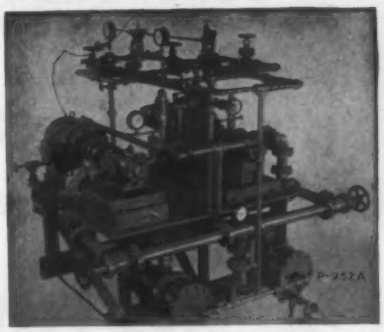
- A petroleum refinery is almost a city within itself. It has its own water supply, electricity, and natural gas for fuel. It also has its own fire department, medical department, and maintenance staff.

•

- A medium-power turbo-jet aircraft engine burns its own weight of petroleum fuel every twenty minutes.

COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER . . .



P-952-A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40—very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1254 East Sedgley Avenue,
Philadelphia 34, Pa.
Southwestern Division:
2512 South Boulevard, Houston 6, Texas

FOR
DEPENDABLE
DELIVERIES
OF

NATURAL GASOLINE

WHATEVER THE GRADE
AND THE VOLUME . . .
WHERE AND WHEN AND THE WAY
You WANT THEM . . .
JUST RELY ON
WARREN'S
VERSATILE FACILITIES!

WARREN
PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

What's Happening . . .

. . . in the Industry

Satellite Will 'Blast-Off' With Kerosine

Fuel for first stage rocket is direct descendent of oil burned in old buggy lamps.

Scientists developing the first stage of the three-stage rocket that will fire the Earth Satellite into outer space for the International Geophysical Year are spiking their celestial high-ball with kerosine.

J. S. Harris, aviation manager of Shell Oil Co., said that the fuel for the satellite's first stage rocket is a "direct but improved descendant of the oil that burned in your grandfather's buggy lamp."

The fuel is a special grade of kerosine, Harris said, produced by a closely controlled refining operation developed by Shell to give the fuel the particular characteristics needed for the rocket. It is being delivered to General Electric's Malta, New York, test site where the first stage rocket engine is being tested.

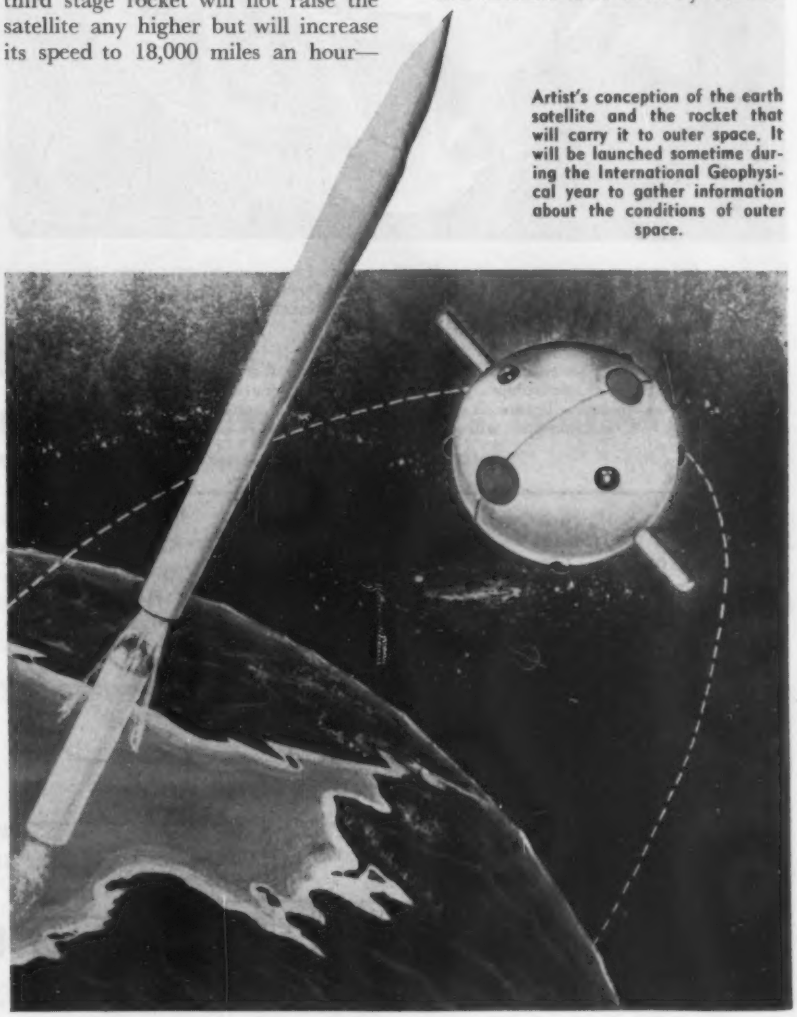
The Earth Satellite is a ball about 20 inches in diameter, packed with scientific instruments. It will be launched into space sometime during the International Geophysical Year (July 1957-December 1958) to gather new information about the earth, its atmosphere and the conditions of outer space.

Power to drive the satellite to the altitude and speed at which it will circle the earth will be provided by three rockets.

The first stage rocket will drive the satellite to a height of about 40 miles and a speed of about 4000 miles an hour. Then the first stage rocket will be jettisoned and the second stage rocket will take over, lifting the satellite to a height of 300 miles and a speed of 9000 miles an hour. The third stage rocket will not raise the satellite any higher but will increase its speed to 18,000 miles an hour—the speed needed to establish the satellite in its orbit.

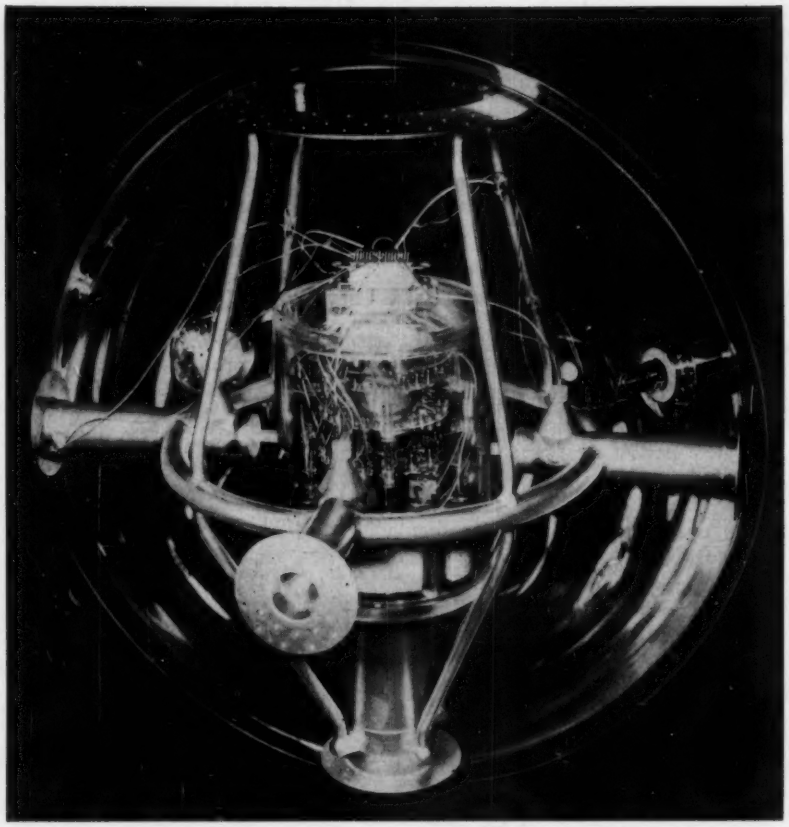
Most of the fuel ordered for the satellite's first stage rocket will be used in development work, Harris said. The actual launching will take relatively little. Once the satellite is in its orbit no more fuel will be needed.

The satellite is a one-way vehicle.



Artist's conception of the earth satellite and the rocket that will carry it to outer space. It will be launched sometime during the International Geophysical year to gather information about the conditions of outer space.

What's Happening . . .



Shown is a full scale model of the satellite. It will be carried into its orbit by a three-stage rocket where it will circle the earth at 18,000 miles an hour. The model was designed and built by scientists assigned to Project Vanguard at the Naval Research Laboratory.

When it drops out of its orbit and heads back into the earth's atmosphere it will burn up like a meteor. Before it does, scientists hope its instruments will have recorded and transmitted to earth a great deal of information useful in planning further ventures into space.

Oil Praised then Criticized

The House Commerce Committee has praised the oil-to-Europe program as a "stupendous achievement on the part of the oil industry," but in the same breath it also criticized the industry for the poor timing of its January price hike.

The report on the committee's recent oil investigation said the price increases were apparently timed to take advantage of the Middle East crisis and Europe's need for U. S. domestic oil.

Commenting on the European oil lift, the report gave high praise. It called the program "eminently successful" in the face of terrific dislocations in normal transportation.

"The success of the suddenly enforced alternate operation cannot but be hailed as a stupendous achievement on the part of the oil industry," the report said.

"The magnitude of the accomplishment merits great recognition when it is appreciated that the supply ratio attained is measured against estimated full normal requirements."

The committee also expressed puzzlement over the confusing statistics that were published in the early months of the European oil lift, which at first indicated that the supply program was lagging, but which later showed it to be a success. Many of the statements of alarm came from government agencies, the committee noted. It said that the reason for the widely-publicized statements is no more comprehensible now than it was several months ago.

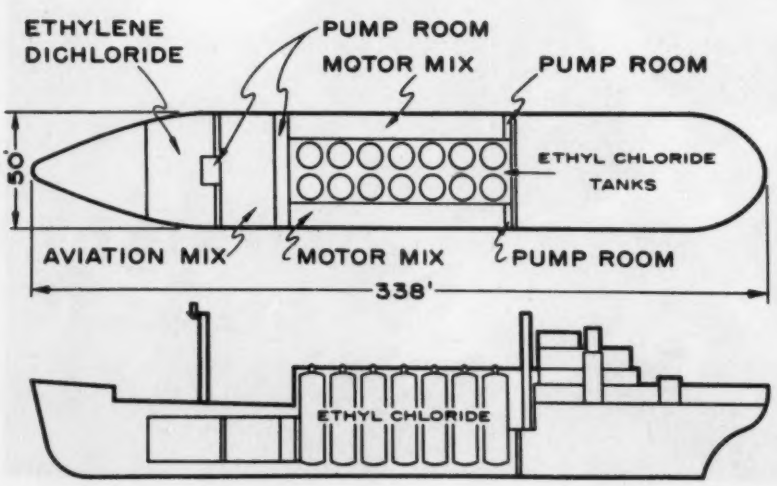
On the question of oil prices, the committee indicated some sympathy for the justification of increases on the basis of rising costs, but it still criticized the timing of the price boosts. The report said that during the past few years when there was no increase in oil prices, there has been an increase in the finding, developing and producing of oil in the United States.

The report then added, "it is regrettable, however, that regardless of any long-run justification arising from economics of cost there may have been for an increase in the price of oil, the price increase early in January of this year appears to have been timed to take advantage of the Middle East crisis and the demand for domestic oil for export to Europe."

First TEL Ship Operating

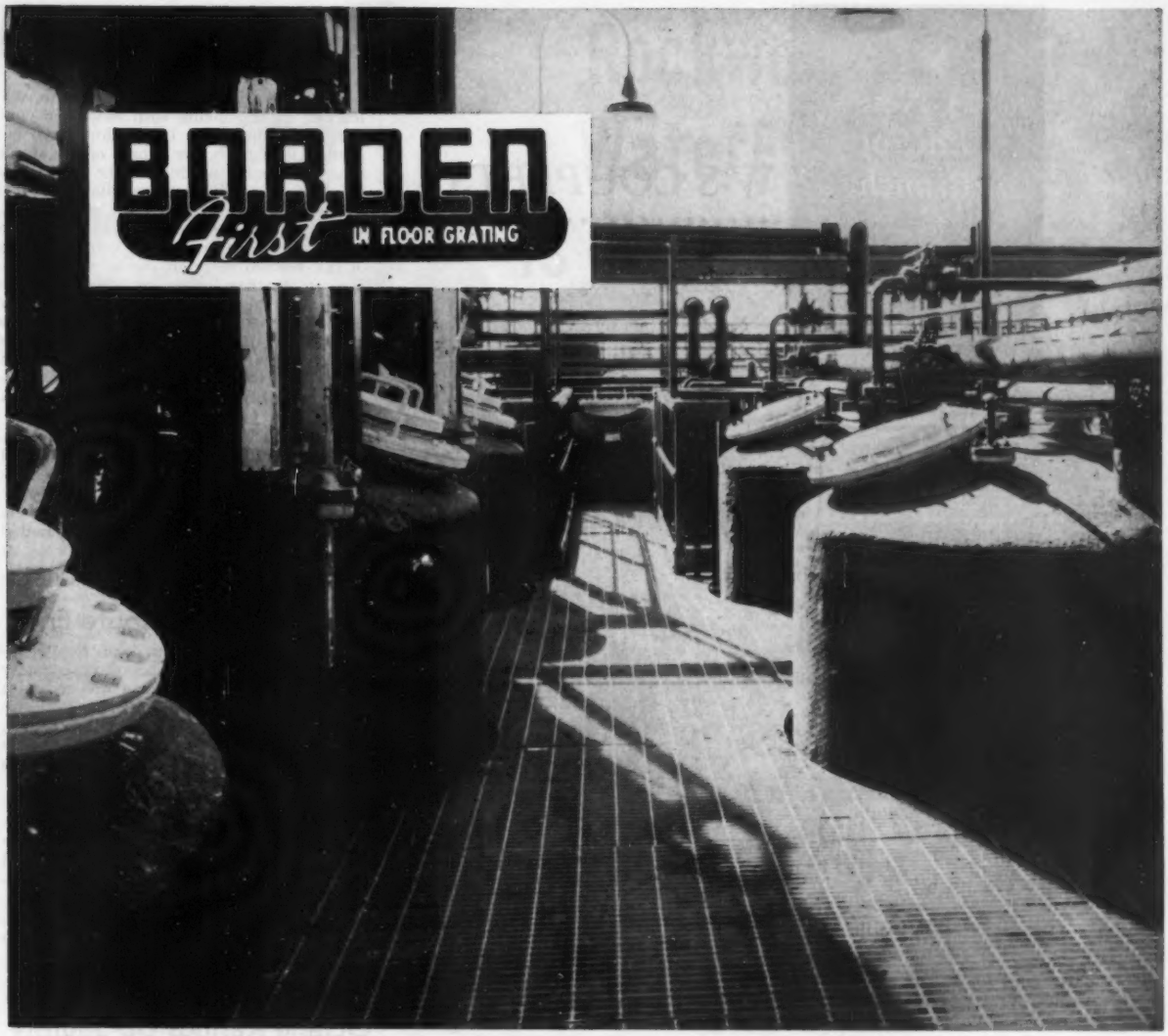
The first ship to transport tetraethyl lead in bulk went into service in April, for the Du Pont Co.'s Petroleum Chemicals division.

The converted dry cargo ship, being leased from Valentine Chemical Carriers, Inc., Oradell, N. J., has been renamed the M. V. Petrochem. It is equipped with 14 upright cylindrical pressure vessels for ethyl chloride and six special steel tanks for tetraethyl lead.



Du Pont's TEL tankship will transport tetraethyl lead from the company's East Coast manufacturing plant at the Chambers Works in Deepwater Point, N. J., to portside facilities in Beaumont, Texas, where a large expansion project has just been completed. The Beaumont installation consists of a new pier, tetraethyl lead blending facilities, new storage tanks, and transfer facilities for shipping the product to refiners throughout the Southwest.

One of the unusual features of the TEL



BORDEN MANUFACTURES EVERY TYPE FLOOR GRATING

FOR THE REFINING INDUSTRY, in ferrous and non-ferrous metals

BORDEN—First in Floor Gratings — is proud of its particular adaption and specialization in gratings for the refinery industry. **Borden's** well-known attention to detail and great familiarity with this special field guarantees complete satisfaction.*

Trouble-free installation is assured by **Borden's** Free Planning and Checking Service: All details and dimensions are carefully checked with the customer before fabrication; the component parts are individually marked for economical, accurate and speedy erection in the field.

*This applies to grating (usually stainless steel) for vessel and tower internals — such as grid trays etc. — as well as for strictly structural applications.

See our Catalog in Sweets

Write for complete information on BORDEN All/Weld, Pressure Locked, and Riveted Floor Gratings in this FREE 16-page catalog

BORDEN METAL PRODUCTS CO.

823 Green Lane Elizabeth 2-6410 Elizabeth, N. J.
Southern Plant — Leeds, Ala. • Main Plant — Union, N. J.

BORDEN METAL PRODUCTS CO.

Gentlemen:

Please send me BORDEN Catalog

NAME .....

TITLE .....

COMPANY NAME .....

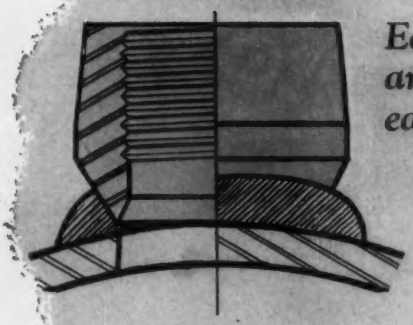
ST. AND NO. .....

CITY AND STATE .....

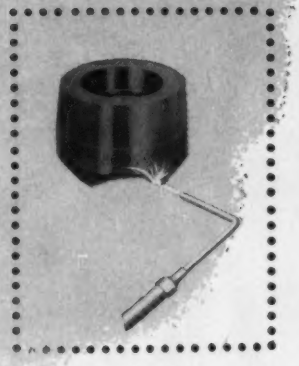
For more data on advertised products, use Readers' Service Cards, last page.

A New Line of Branch Connections

W-S COUPLETS



Economical and easy-to-install



Readily modified for small diameter installation

W-S Couplets are designed to function as universal outlet connections for tanks, process vessels and pipelines. They eliminate the need for large, expensive field inventories and costly delays in fabrication.

On most tank, and large piping installations they are used as received. On those few applications where attachment is to be made to a small diameter pipe, the W-S Couplet is easily modified by contouring the welding end with an acetylene torch to mate with the curvature of the pipe diameter. Couplets are made with extra length and heavy wall to permit contouring without detriment to the threaded or socket end.

W-S Couplets are available in sizes ¼" through 2", with screw-end or socket-welding dimensions ... also in a 90° elbow.

Send for Bulletin CP-1-57. Write to W-S Fittings Division, H. K. Porter Company, Inc., P. O. Box 95, Roselle, N.J.

HKP W-S FITTINGS DIVISION
H. K. PORTER COMPANY, INC.

What's Happening ...

tankship is that it is equipped with unloading arrangements with swingline connections mounted on board ship. The tetraethyl lead tanks are a part of the ship's structure, being welded to the ribs, with the surface of the tanks available for inspection. As a safety measure, these tanks, which are below deck, have a separate bilge system preventing the contamination of the normal bilge in the event of spillage. As further protection, there are five cofferdams to divide the ship into six liquid-tight compartments. Provisions also have been made for taking air samples below deck while standing above deck, and equipment has been installed to change the air completely in the below-deck spaces once every three minutes.

The ship, which has a deadweight tonnage of 6000 tons and can make the round trip in less than three weeks, will pick up raw materials on the Gulf Coast before making return trips to the Chambers Works. Ethylene dichloride will be loaded at Port Neches and ethyl chloride at Houston.

Calgary Zone Dispute Ends

The Calgary city council has finally approved a zoning dispute compromise under which Imperial Oil Co. may proceed with the $17 million expansion and modernization of its refinery. Among other things, the company will provide for the citizens of Calgary an $80,000 swimming pool, a $10,000 community hall, and a park.

These concessions by Imperial were approved over strong protests by some aldermen that the agreement suggested that the residents of the district were being bribed and thus could set an embarrassing precedent.

The Calgary citizens had appealed to the courts against the re-zoning of the 260 acres from agricultural to industrial use, but the suits have now been dropped.

Octane Ratings Up Slightly

Gasoline on sale at service stations in April rose to national weighted averages of 97.7 octane number for premium and 90.6 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corp.

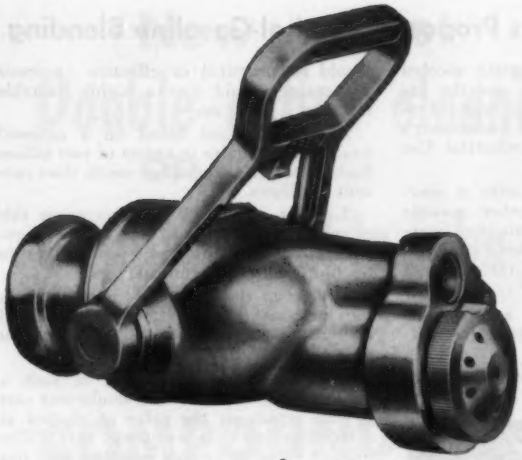
The premium gasoline average was 0.2 number above the March level and 1.4 octane numbers above a year ago. The regular gasoline average was up 0.1 octane number over March and 1.3 octane numbers higher than a year ago.

Average tetraethyl lead contents in April were 2.53 ml per gallon of premium gasoline and 2.03 ml per gallon of regular gasoline.

The April survey presents, for the first time, data on the highest grade of gasoline for those companies marketing more than one grade of premium. Although it does not present any averages, the survey lists the octane number and TEL content of 28 samples in 15 cities. The survey showed that the octane number of these samples ranged from 100 to 101.6 (Research).

Thirty-four of the 57 cities in Ethyl's survey reported increases over March in the average octane number of their premium gasoline, nine of them by 0.5 octane

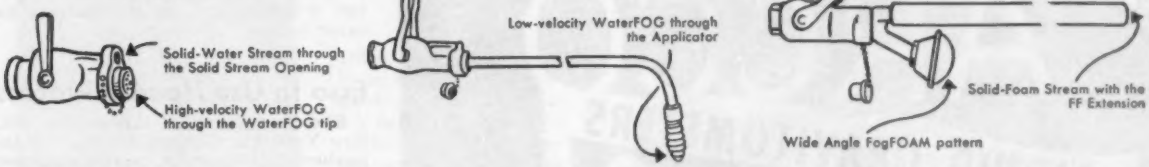
For more data on advertised products, use Readers' Service Cards, last page.



Rockwood SG-60 WaterFOG Nozzle is five nozzles in one

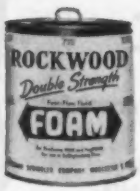
The lightweight Rockwood SG-60 WaterFOG Nozzle *eliminates "special" or single-purpose nozzles!* It actually does the work of five nozzles to put out fires faster, safer and more economically.

Here's what we mean . . .

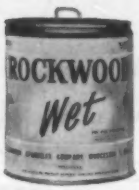

Solid-Water Stream through the Solid Stream Opening
High-velocity WaterFOG through the WaterFOG tip
Low-velocity WaterFOG through the Applicator
Solid-Foam Stream with the FF Extension
Wide Angle FogFOAM pattern

Here's what you need to put out ordinary combustibles and flammable liquids . . .

FOAM and "Wet" Eductor with the new FW Metering-Check Valve. Introduces Rockwood FOAM or "Wet" into hose lines, automatically proportioning correct amount of FOAM and "Wet" to water. Also usable wherever one liquid is fed into another on a fixed percentage basis.



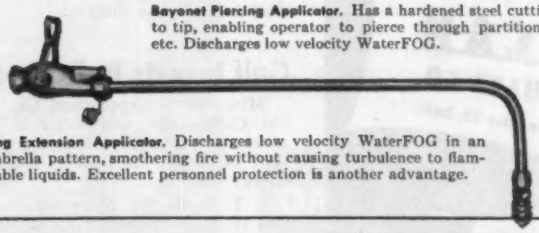
Rockwood Double Strength FOAM. Puts out fires in flammable liquids, and in ordinary combustibles, quicker, at lower cost. Three parts FOAM and 97 parts water create a heat-resistant blanket.



Rockwood WET. One part WET mixed with 99 parts water increases water's penetration and extinguishing action. Gives quickest results against deep seated fires. Saves time, water, manpower.

FF Extension Unit. Shown with Type SG-60 Nozzle. Discharges Rockwood FOAM in a solid stream or as Fog-FOAM. Wide angle makes it possible to cover large areas at one time.

Bayonet Piercing Applicator. Has a hardened steel cutting tool attached to tip, enabling operator to pierce through partitions, into interiors, etc. Discharges low velocity WaterFOG.



Long Extension Applicator. Discharges low velocity WaterFOG in an umbrella pattern, smothering fire without causing turbulence to flammable liquids. Excellent personnel protection is another advantage.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Distributors in all principal industrial areas

and here's the way to get more information

ROCKWOOD SPRINKLER COMPANY

Portable Fire Protection Division
1612 Harlow Street
Worcester 5, Massachusetts

Please send me your illustrated booklet on Rockwood fire-fighting products.

Name .....

Title .....

Company .....

Street .....

City .....

Zone ..... *State* .....

For more data on advertised products, use Readers' Service Cards, last page.

number or more. Nine cities reported decreases while 13 cities were unchanged. In regular gasoline, 29 cities reported increases over March in their average antiknock quality, six by 0.5 octane number or more. Seventeen cities reported decreases, and 10 cities remained unchanged.

Compared with nationwide premium average of 97.7 octane number, nine cities reported premium averages of 98.5 octane number or higher. In regular gasoline 16 cities showed average octane ratings of 91.5 octane number or higher, compared with the national weighted average of 90.6 octane number.

Commission Rejects Proposed Alcohol-Gasoline Blending

Compulsory blending of grain alcohol with gasoline as a means to end the nation's grain surplus has been rejected as "impracticable" by President Eisenhower's Commission on Increased Industrial Use of Agricultural Products.

Reporting to Congress after a nine-month study of this and other possible solutions to the farm problem, the Commission concluded, "It appears clear that the cost to the public would far outweigh the possible advantages."

Terming the key problem an economic one, the group summarized its major findings as follows:

1. No blend of less than 10 percent would be practical or effective (a lesser percentage would give a highly unstable mixture).

2. A 10 percent blend on a national basis would require in excess of two billion bushels of grain annually—more than current surpluses.

3. Plant capacity for processing this quantity of grain would cost in the neighborhood of $2 billion and would have to be built with government funds.

4. Cost to the motoring public through the increased price of motor fuel would amount to an additional $1 to $2 billion annually.

Even disregarding the cost of such a program, moreover, serious doubt was cast by the report on the value of alcohol as a blending stock. It was noted that, "The relative value of alcohol in motor fuel has decreased year by year as the octane number of motor fuel has increased . . . Furthermore, the addition of alcohol to motor fuel greatly increases the tendency for vapor locking."

ARCCO
LIQUID GRAVITOMETERS
NOW 19 MODELS
MODEL RES
ARCCO—Anubis
For RECORDING, SIGNALLING
TRANSMITTING and CONTROLLING
For pipelines, refineries, chemical plants, etc., ARCCO Anubis Liquid Gravitometers are ruggedly built for hard field usage yet are accurate in performance as a laboratory instrument.
Temperature corrected, these extremely accurate instruments are adaptable to high pressures and are available with internal parts suitable for practically all corrosive liquids.
Send for Bulletin No. 111R-3.
AVAILABLE FOR EARLY DELIVERY
AMERICAN RECORDING CHART CO.
3113 E. 11th St. • Los Angeles 23, Calif.
Send for Bulletin 111R-3

Esso to Use Houdry Process

Esso Research and Engineering Co., New York, has acquired a license for the production of butadiene, butenes and other light olefins by the Houdry Dehydrogenation process, it was announced by Houdry Process Corp.

This fixed-bed process is noteworthy for single-step production of butadiene, butenes, or both concurrently, from normal butane or butane-butene mixtures. The process is also adaptable to the dehydrogenation of other light hydrocarbons.

Butadiene is the major ingredient in the manufacture of synthetic rubber.

No announcement has been made as to Esso's plans in connection with the process.

Explosion at Magnolia Plant

An explosion rocked the Beaumont refinery of Magnolia Petroleum Co. April 22, killing two men. The unit which blew up was a salt tower, part of a copper chloride sweetening unit which handles 14 pound natural gas. Company officials believe that oxygen, which is used in the sweetening unit, worked its way to the top of the tower and caused the explosion.

The copper chloride unit has been shut down but officials say that except for the salt tower which was split open, damage to equipment was light.

One of the men was killed instantly, while the other who was badly burned, died later in the hospital.

Gulf Invests In Rocket Fuel

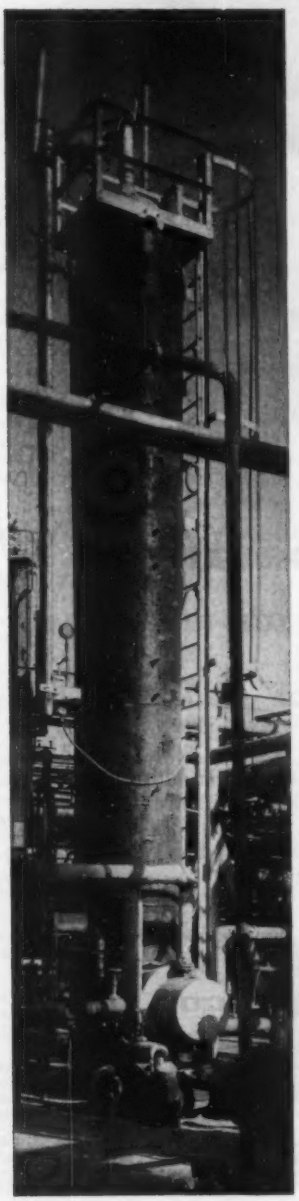
Mine Safety Appliances Co. and Gulf Oil Corp. have undertaken a joint program for research and production in the field of boron chemistry, including high energy fuels.

J. T. Ryan, Jr., Mine Safety president, and W. K. Whiteford, Gulf president, have announced that the joint effort will be carried on by Callery Chemical Co. Callery recently broke ground at Muskogee, Okla., for a $38 million high energy fuel plant under a contract with the Navy department.

The high energy fuel to be produced

For more data on advertised products, use Readers' Service Cards, last page.

Now you get Double-action cleaning on Double-trouble jobs with OAKITE COMPOUND No. 85



Those tough soils built up on refinery equipment are doubly tough to clean — a solvent is needed for removing carbon deposits, and then an acidic cleaner for iron oxides and sulphides.

Now, with new Oakite Compound No. 85, you can do both jobs at the same time — remove carbon *and* iron oxides and sulphides in a single cleaning operation on absorbers, debutanizers, de-ethanizers, feed stock preheaters, heat exchangers, stabilizers. O.C. 85 gives you these extra advantages:

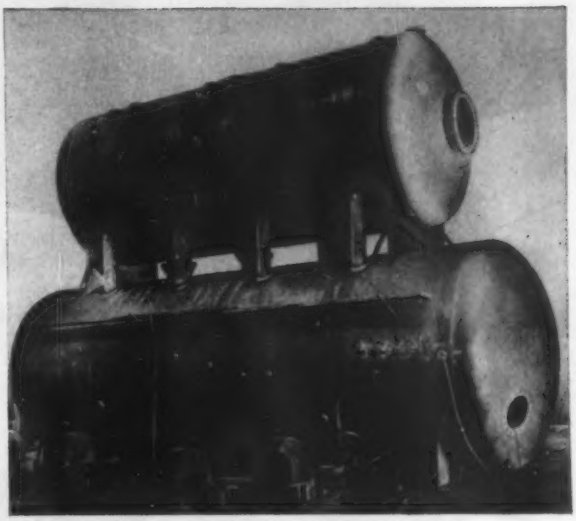
- Fast soil penetration
- Does not attack steel
- Long-lasting solutions
- Rinses freely
- Safer than raw acids

Ask your local Oakite Technical Service Representative to show you how Oakite Compound No. 85 can save you considerable off-stream time. Or write for Bulletin F3751 to Oakite Products, Inc., 48 Rector Street, New York 6, N.Y.

OAKITE

Export Division Cable Address: Oakite

Let POSEY Fabricate Your Special Jobs!



Fabricating a Special Feed Water Heater like this one . . . upper unit 9'6" x 21' and the lower unit 11'6" x 36' . . . requires much in the way of know-how, facilities and skilled workmen. Posey Iron has been fabricating a wide variety of steel vessels and structures for almost a half-century. Today this backlog of experience is backed up by modern equipment and engineering facilities to meet your most unusual requirements and specifications. Let Posey quote on your steel fabrication jobs. Your request will receive immediate attention.

Steel plate fabrication by Posey meets all ASME, API-ASME and API codes.

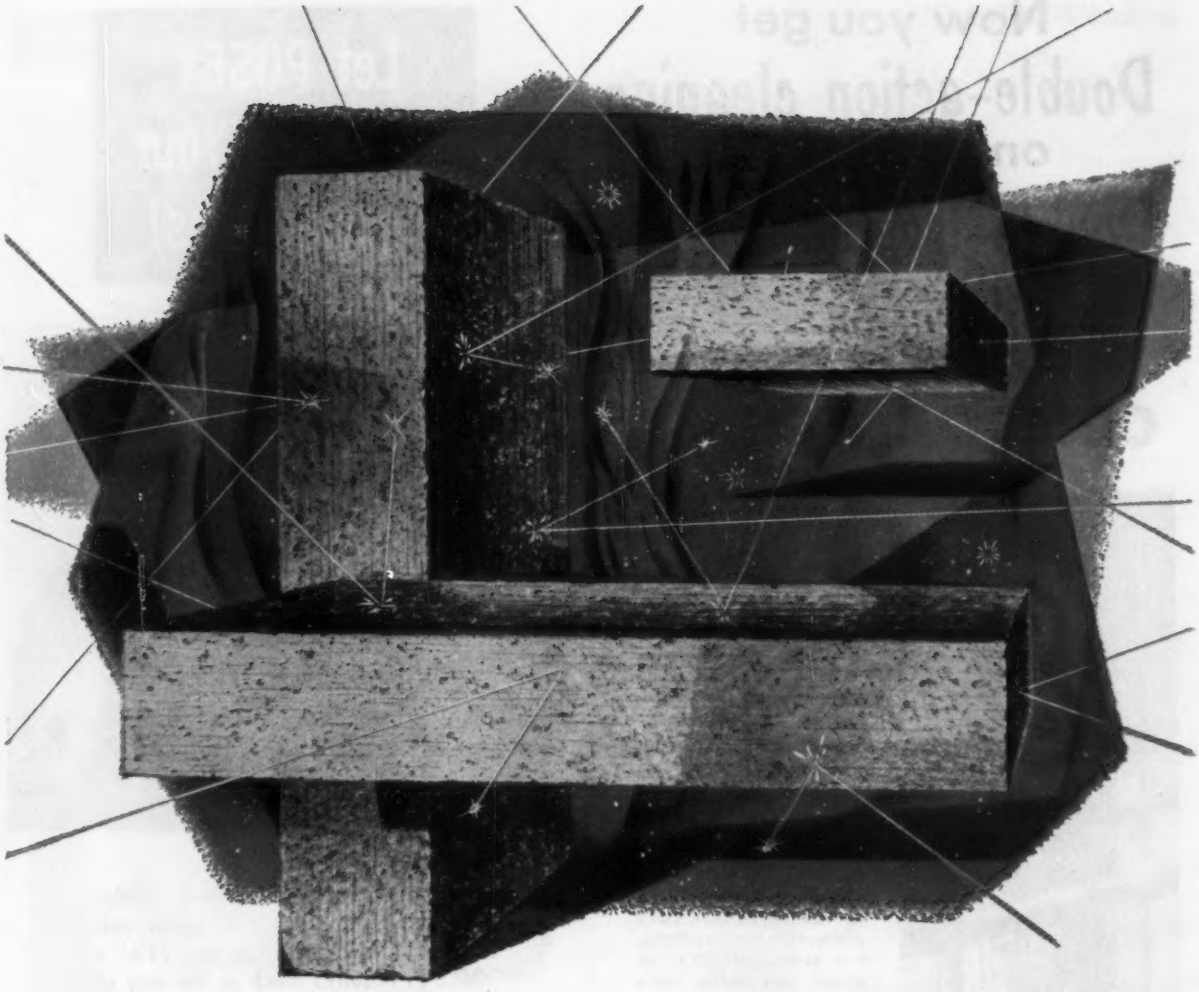
POSEY IRON WORKS, INC.

Steel Plate Division

LANCASTER, PENNSYLVANIA

New York Office: Graybar Building

PRESSURE VESSELS ● TANKS
STACKS ● DIGESTERS ● PILING
DREDGE PIPE AND ACCESSORIES



Go ahead! Raise process temperatures

. . . refractories fortified with Alcoa Aluminas can take it

Process temperatures continue to climb in industry's constant effort to raise production and product quality while cutting costs. That makes more important than ever the role of ALCOA® Aluminas in fortifying refractories. To see why, study these performance facts:

As alumina content of a refractory increases . . .

- **strength and stability under load at high temperatures increase**
- **there is less spalling, abrasion and fluxing**
- **co-efficient of expansion decreases**
- **resistance to chemical attack improves**
- **effective service life grows longer and longer**

For users of high alumina refractories, the money-making results are these: less downtime . . . less rebuilding . . . longer continuous equipment operation under uniform conditions to raise production tonnages and maintain product quality . . . easier product development.

First cost of high alumina refractories is surprisingly low, too . . . because ALCOA Aluminas are among the least costly, *uniformly pure oxides* available in quantity and suitable for refractory use.

Look at it as you will! Refractories fortified with ALCOA Aluminas are *your* best answer to the plaguing problems of suitable refractory performance in today's super-high temperature operations.

ALCOA does not make refractories! We will gladly refer you to a reliable supplier who uses ALCOA Aluminas to make *better* refractories. For additional information, write ALUMINUM COMPANY OF AMERICA, 717-E Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

at this plant is called "HiCal," a mixture of boron, hydrogen and carbon. It is expected to power jet aircraft and missiles to new peaks of efficiency and performance. This plant is part of the Navy's closely guarded "Project Zip."

Rear Admiral C. S. Cooper, deputy and assistant chief of the Navy's Bureau of Aeronautics, described the "HiCal" plant as the initial step in a venture "which might some day be as far reaching in its effect as was the discovery of oil."

Although characteristics of the "zip" fuel are a military secret, the Navy revealed it will multiply the range of a jet aircraft or missle and permit flying at altitudes substantially higher than any aircraft can reach today without rocket power.

"HiCal" can be used efficiently at altitudes where ordinary fuels will not burn. The additional energy it provides can extend range, reduce weight of an airframe, increase payload, or improve tactical performance such as speed and climb.

LPG Stocks Show Decline

Underground stocks of liquefied-petroleum gases on February 28, totaled 285 million gallons, a decrease of 13 million gallons during the month, according to the Bureau of Mines, U. S. Department of the Interior.

Of the total, 231 million were concentrated in Alabama, Mississippi, Louisiana, Texas, and New Mexico, and the rest was distributed through New York, Michigan, Illinois, Kansas, Oklahoma, and Montana.

Underground stocks of propane totaled 143 million gallons, a decrease of 41 million gallons; butane 126 million gallons, an increase of 27 million gallons; and butane-propane mixture 16 million gallons, an increase of 1 million gallons.

Group Will Study Refining

Walter S. Hallanan, Chairman of the National Petroleum Council has announced the appointment of a committee to study and report on the United States refinery capacity.

The Director of the Department of Interior's Oil and Gas division, according to Hallanan, requested the National Petroleum Council to ascertain the facts regarding the U. S. petroleum refinery capacity by principal refinery areas as of January 1, 1957. This will show anticipated increases in capacity resulting from facilities now under construction or facilities planning construction. Consideration will be given to crude oil throughput capacity, information on capacity for thermal cracking, catalytic cracking, thermal reforming, catalytic reforming, hydrogenation, and alkylation (aviation and motor).

The committee on United States Refinery Capacity is headed by Clyde T. Foster, president, Standard Oil Co. (Ohio), Cleveland.

Other members of the committee are Robert O. Anderson, president, Malco Refineries, Inc., Roswell, New Mexico; Jacob Blaustein, president, American Trading & Production Corp., Baltimore; Reid Brazell, president and general manager, Leonard Refineries, Inc., Alma, Michigan and President of the Western Petroleum Refiners Association; Bruce K. Brown, president, Petroleum Chemicals, Inc., New Orleans; Rainey Elliott of Jones & Laughlin Supply division and

Verti-Line® Pumps offer your choice of impellers

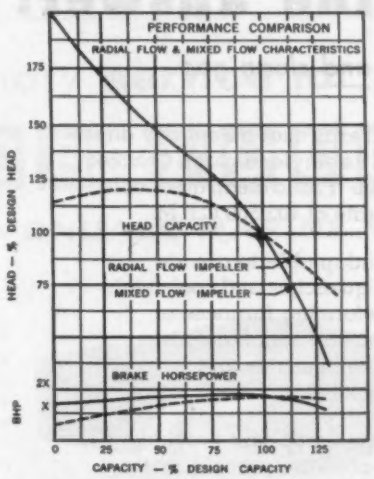
To meet a wide range of exacting pumping conditions, Verti-Line Close-Coupled Industrial Pumps are available with two impeller types.

RADIAL-FLOW

The flat head capacity characteristic of the Radial-Flow impeller is applied to systems such as fueling, condensate return, and cooling towers, which operate at constant pressure against varying capacities and under throttled conditions.

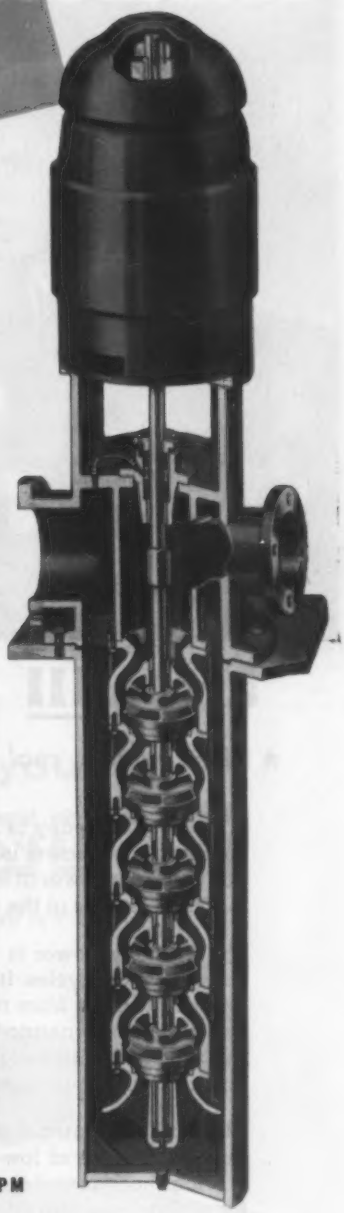
MIXED-FLOW

The steep head-capacity characteristic of the Mixed-Flow impeller is applied where constant capacity is required at fluctuating pressures such as pipeline pumps or units operating in parallel or series.



CAPACITIES from 20 GPM to 30,000 GPM

— HEADS to 600 PSI

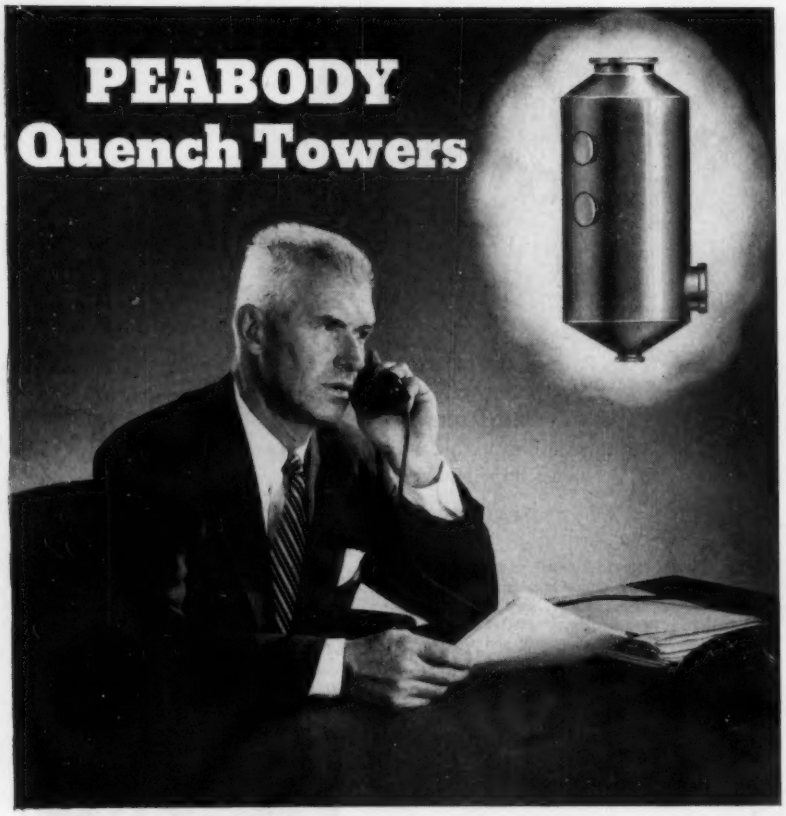


There's a Verti-Line Pump designed to fit your particular application.
Whatever your needs for vertical pumps may be, investigate Verti-Line before you buy! Verti-Line Pumps are sold and serviced by independent distributors and dealers only.

Send for new literature. Ask for Bulletin T-57

Verti-Line Pumps are the exclusive products of
LAYNE & BOWLER PUMP COMPANY
general offices and main plant
2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.



are still the answer!

★ *They quench, cool and clean gas—*

A large oil company in Texas uses a Peabody direct-contact quench tower in its ethylene plant. Cracked gas enters the tower at 600° F. and clean gas, cooled to 100° F., leaves at the rate of 103,500 C.F.M.

The Peabody Tower is adaptable to a wide variety of flow cycles. It quenches and cools high temperature gas from reforming furnaces or synthesis gas generators, and *simultaneously* removes particulate matter, such as tars and carbonaceous material.

This compact, low-pressure-drop unit provides minimum usage of low-pressure process water. It brings hot gas and coolant into intimate contact for positive mass transfer – gas can be cooled to within a few degrees of liquid inlet temperature. Outlet gas temperature and general performance can be held constant over a wide range of flow rates.

If you want clean, dry, cool gas, use a Peabody Tower.

PEABODY ENGINEERING CORPORATION

232 MADISON AVENUE, NEW YORK 16, N. Y.

OFFICES IN PRINCIPAL CITIES

PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

7-101

What's Happening . . .

President, Petroleum Equipment Suppliers Association, Tulsa; George T. Goggin, Douglas Oil Co. of California and president, Independent Refiners Association of California, Paramount; George B. Hunter, Quaker State Oil Refining Corp. and president, National Petroleum Association; W. W. Keeler, Phillips Petroleum Co., Bartlesville, and chairman of the Military Petroleum Advisory Board; M. J. Rathbone, president, Standard Oil Company (N. J.), New York; M. H. Robineau, president, The Frontier Refining Co., Denver, and president, Independent Refiners Association of America; Roland V. Rodman, president, Anderson-Pritchard Oil Corp., Oklahoma City; Reese H. Taylor, chairman of the board, Union Oil Co. of California, Los Angeles; and Dr. Robert E. Wilson, chairman of the board, Standard Oil Company (Indiana), Chicago.

Must Give Merger Notice

A House antitrust subcommittee has approved a bill whereby large corporations—including oil companies—would have to give advance notice to the government prior to accomplishing certain mergers.

Under the provisions of the bill, companies whose combined assets exceed $10 million would have to halt any merger action for 60 days after notifying the Justice Department and the Federal Trade Commission.

During this period, government agencies could take antitrust action if they felt proposed action would violate antitrust laws.

The bill, which is sponsored by Chairman Celler (D-N.Y.) now goes before the full Judiciary Committee.

Just One Full Argentina Bid

Fifteen Argentine, U. S., European, and Japanese firms have submitted bids for construction of refineries and a system of oil and gas pipe lines for the Argentine national entity, Yacimientos Petroliferos Fiscales, under its projected $250 million expansion program.

When the bids were opened at YPF headquarters in Buenos Aires, however, only one group had made a comprehensive offer. The rest of the bids merely covered parts of the plan such as pipe lines, labor, communications, or refinery equipment.

The group making the principal offer uses the name of ICSA, and is comprised of U. S., British, French, Belgian, Dutch, Italian, Panamanian, and Argentine interests. Its bid contemplated financing the project in dollars, sterling, Belgian francs, florins, and pesos.

Crude Imports Being Studied

Robert L. Wood, President of the Independent Petroleum Association of America said in Washington recently that, "The action of ODM Director Gray in certifying to the President that he has reason to believe crude oil is being imported into the United States in such quantities as to threaten to impair the national security is an indication of further recognition of the oil import problem.

"It is therefore encouraging that Director Gray has taken this action," he added.

Wood went on to say that the domestic oil industry has been faced, too long, with excessive oil imports. Positive action to limit these imports within the 1954 rela-

For more data on advertised products, use Readers' Service Cards, last page.

CENTRIFUGAL SYNTHESIS GAS CIRCULATORS

GHH Maulwurf pumps are high pressure centrifugal gas circulators especially designed for application in the chemical industry to increase the pressure of the nitrogen-hydrogen mixture in ammonia synthesis.

COMPRESSORS	PRESSURE VESSELS
BLOWERS	HEAT EXCHANGERS
EXPANDERS	COLUMNS

GUTEHOFFNUNGSHÜTTE
STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

REPRESENTATIVES: THE FORAM CORPORATION
15 Moore Street, NEW YORK 4, N. Y. • Telephone: WHitehall 3-8241

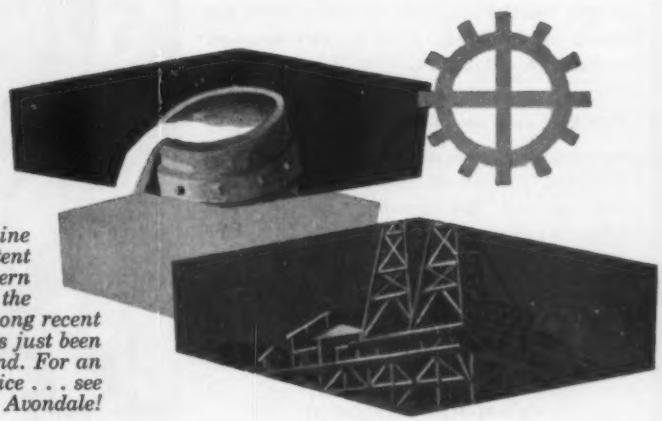
---

a better Foundry service for you . . .

SERVICE FOUNDRY

A DIVISION OF AVONDALE MARINE WAYS, INC.

Foundries have come a long way since the forge and bellows . . . today they are mechanized and specialized, offering a wide variety of products and services including engineering and design. This is certainly true of SERVICE FOUNDRY, a division of Avondale Marine Ways, Inc. In addition to a complete foundry and machine shop service, there is a large and competent staff of engineers, draftsmen, and pattern makers highly skilled in meeting the requirements of your industry. Among recent improvements, a new electric furnace has just been installed—the most modern of its kind. For an all-around better *foundry service . . . see Avondale!*



SERVICE FOUNDRY a division of Avondale Marine Ways, Inc.

416 Erato St. New Orleans, La. CAnal 3836

More than a mere pipe fitting!
catawissa
PERFECT SEAL
unions
give a 3 to 1
safety factor
PLUS
A PERFECT SEAL!
THERE'S A CATAWISSA PERFECT SEAL UNION FOR EVERY USE . . . ALL TEMPERATURES, ALL PRESSURES!
The full dependability of HOT FORGED STEEL is yours in a Catawissa Union (hot forged from solid steel bars) with several extra value features that are exclusive here at the UNION SPECIALISTS!
All Catawissa Unions are designed to give a 3-to-1 SAFETY FACTOR . . . 3,000-lb. service unions are tested to 9,000-lbs., 6,000-lb. service unions tested to 18,000-lbs., etc.
Exclusive Ball-to-Angle seat design assures a PERFECT SEAL even when the pipe is not in alignment!
Machining operations assure a UNIFORMITY AND ACCURACY heretofore found only in special fittings and, with rigid inspection both during and after machining, guarantees LEAKPROOF CONSTRUCTION!
Satisfaction is guaranteed in any application—whether it be general low pressure service or extremely high pressures and temperatures (for air, oil, gas, chemicals, hot oils, gases or steam).
WRITE FOR CATALOG 11
AVAILABLE FROM LEADING INDUSTRIAL SUPPLY FIRMS
CATAWISSA VALVE & FITTINGS COMPANY
23 MILL STREET ★ CATAWISSA, PENNA.

What's Happening. . .

tionship is imperative if the domestic industry is to remain the principle bulwark of our national security.

"The President has announced he will initiate an investigation under the Defense Amendment (Section 7 of the Trade Agreements Extension Act of 1955). The question of oil imports has been under close and continuous study for the past two years. It is hoped any such investigation will require the minimum of time."

President Eisenhower has requested that Director Gray examine the possibility of limiting oil imports by voluntary action of the importing companies. Wood contends, however, that, past experience has demonstrated the futility of a solution by this method.

Ike to Study Tax Credits

President Eisenhower has promised to take a look at the question of U. S. Income Tax credits received by American oil companies for taxes paid to Mideast nations.

The chief executive said that he would talk to Treasury Secretary Humphrey about the matter. Treasury officials, however, doubted that a formal report would be prepared for the President, but said they expected that he may be briefed in an informal conversation.

The whole matter revolves around a section of the tax code which allows American companies a credit against U. S. income taxes for taxes paid to foreign governments. Therefore, if an American company has a tax bill of $1 million and pays a foreign tax bill of $500,000, it can use the foreign payment to reduce its U. S. tax liability.

During the recent O'Mahoney subcommittee hearings, it was brought out that the Arabian American Oil Co., which is owned by four American companies, has in recent years, wiped out its U. S. tax bill completely by claiming taxes abroad.

Cost Engineers to Meet

The American Association of Cost Engineers will hold its first annual meeting at the University of New Hampshire, Durham, N. H., June 26-29, 1957.

A technical program has been arranged including papers on:

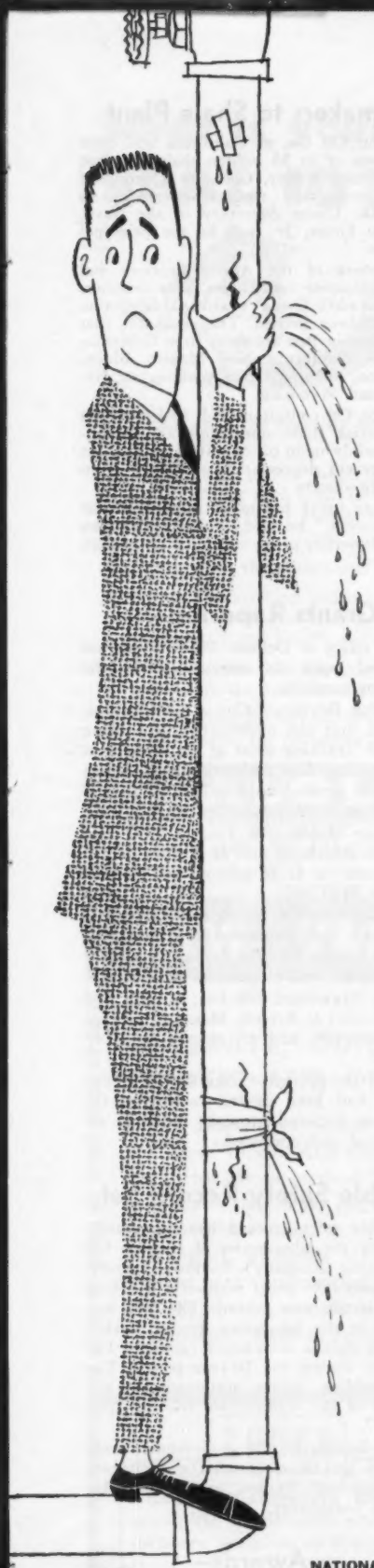
- Industry's Capital Spending Plans.
- Cost Indexes and Cost Trends.
- Depreciation Effects on Payout Time and Project Desirability Appraisal.
- Overhead Expense Distribution for Multiple Use Plants.
- Adapting Construction Cost Records to Property Records.
- Capital Estimating by Ratio Methods.

There will also be a symposium on Operating Costs.

Major Forms New Company

Standard Oil Co. of California has established California Chemical Co. to consolidate its expanding chemical activities.

The new organization will coordinate activities of two presently existing subsidiaries, California Spray-Chemical Corp., manufacturer and marketer of agricultural



You say you have a pressure problem?

Nothing serious, we hope. But if you'd like some assistance with it just call on "National Tube." Pressure problems are our specialty. So are temperature problems, acids, oxidation, corrosion—in fact, all types of refinery tubing problems. We like to solve them.

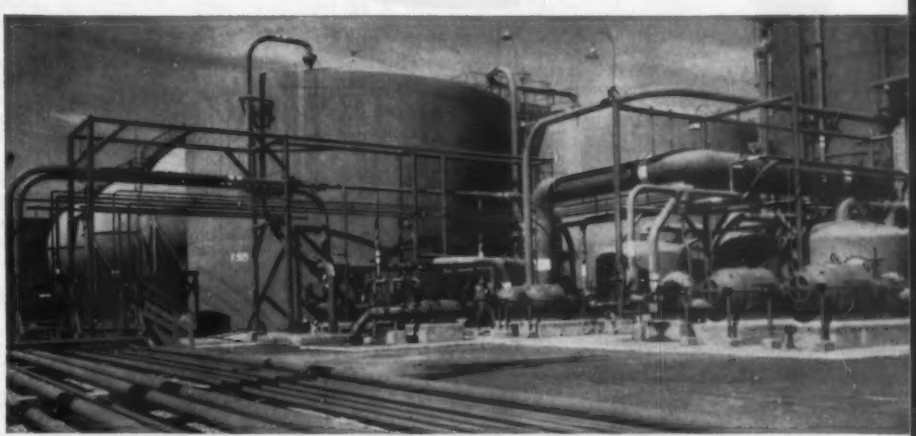
You see, we have a system. Here, at National Tube, we've kept case histories for many years—data on thousands of tough refinery tubing problems, each one solved by a specially prepared steel alloy. The result of this accumulation of knowledge is concentrated in 24 different steel tube analyses, each designed to combat a specific set of refinery conditions. Long, rigorous testing in actual refinery service has proved the capabilities of every one of these analyses.

In addition to these two dozen analyses, other chemical compositions are available in tubular products, and a wide variety of temperature problems is presently under study.

So, get in touch with us. Our Mill Service Force, available for field consultation, will help you find just the alloy you need, at the right price, to meet your refinery conditions. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

HERE ARE NATIONAL TUBE'S TWO DOZEN DIFFERENT TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

WALLS WITHOUT WELDS

NATIONAL SEAMLESS PIPE AND TUBES

U N I T E D S T A T E S S T E E L

What's Happening . . .

chemicals; and Oronite Chemical Co., which functions in the field of industrial chemicals. California Spray-Chemical and Oronite Chemical will become subsidiaries of California Chemical Co.

Additionally, California Chemical will engage in long-range planning and guide the anticipated future growth of California-Standard's participation in the chemical industry.

G. L. Parkhurst has been named chairman of the board and chief executive officer of California Chemical Co. P. L. Fahrney has been named president. Both are vice presidents of Standard Oil Co. of California.

Named vice presidents of the new company were T. G. Hughes, president of Oronite; and A. W. Mohr, president of Calspray.

Shale Oil Plant Doing Well

Union Oil Co.'s commercial prototype of a shale oil producing plant is performing as well or better than originally expected, a company research executive said recently.

Union began operating the plant in the Colorado oil shale beds last month. The plant melts oil out of crushed shale with a vertical retort.

Lawmakers to Shale Plant

Union Oil Co. of California will open the doors of its $5 million shale oil plant near Grand Valley, Colo., to a group of congressmen and western governors on May 18. Under Secretary of the Navy, Thomas Gates, Jr., will be the principal speaker.

Members of the Armed Services and House Interior committees, plus members of Colorado's Congressional delegation have all been invited. The governors that have been invited are those from Colorado, Arizona, California, New Mexico, Idaho, Montana, Oregon, Utah, Washington, Nevada, and Wyoming.

Union Oil consultant Tell Ertl said that commercial shale operations are contingent mainly upon oil operators getting the 27.5 percent depreciation allowance given crude producers.

"A tax break has to go along with the development," he said, "unless extraction costs ultimately prove out much lower than expected."

Tax Grants Reported

The office of Defense Mobilization has approved rapid tax amortization for the following projects:

Phillips Petroleum Co., a 6200 bpd alkylation unit and modification of existing catalytic cracking units at the refinery at Kansas City, Kan.; 65 percent on $750,000; 100 percent on $5,475,000; and 40 percent on $300,000.

Socony Mobile Oil Co., a 9000 bpd catalytic reforming unit at Buffalo, N. Y.; 65 percent on $2.48 million, and 45 percent on $410,000.

Delhi-Taylor Oil Co., a 2500 bpd alkylation unit and expansion of crude topping at Corpus Christi, Texas; 65 percent on $500,000, and 45 percent on $185,000.

Esso Standard Oil Co., a 7200 bpd Hydroformer at Everett, Mass.; 65 percent on $3,285,400, and 45 percent on $14,890,600.

All of the projects except that of Delhi-Taylor had been denied earlier by the ODM on dispersal grounds, but were reconsidered and approved.

Humble Safety Record Set

Another safety record has been established by the laboratories of Humble Oil & Refining Company's Baytown refinery. Ten consecutive years without a disabling injury is the new record. The 550 employees in the laboratory groups worked over ten million man-hours (actually 10,435,000) during the 10-year period. The last disabling injury sustained by any member of the organization was on April 14, 1947.

Participating in the achievement were Research and Development Division, Service Laboratory Division, and Humble Inspection Laboratory.

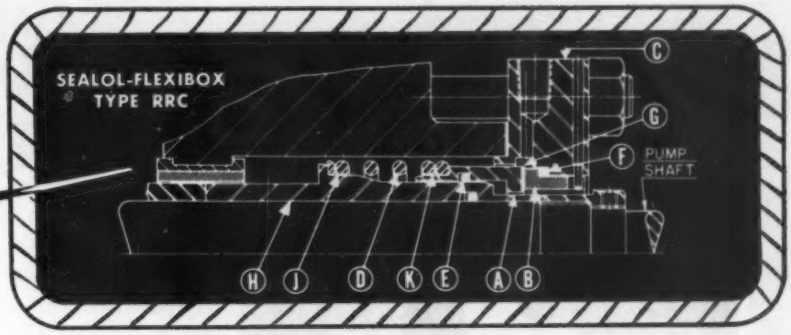
—Awards—

Eight petroleum companies were among the recipients of the National Safety Council's 1956 Public Interest award.

The advertising campaigns of eight com-

For more data on advertised products, use Readers' Service Cards, last page.

what is your SEAL IQ?



Q. Which are the rotating components of the above seal assembly?

A. In addition to the shaft; sleeve (H), drive spring (D), rotary seal ring (A), and rotary seal ring packing (E), all rotate with the shaft or rotor assembly.

Q. What turns the rotary seal ring?

A. Torque is applied uniformly through the unique Flexibox spring (D) by means of interference fits at points J and K. No pins or lugs are required.

Q. What is the suitable pressure range for the seal shown on the blackboard?

A. The design illustrated is a hydraulically balanced seal suitable for pressures up to 1000 psig.

Q. Where are the sealing faces?

A. Sealing faces are shown at point G where the rotary seal ring contacts the stationary seal ring face.

Q. How is the seal adjusted to set spring loading?

A. Integral sleeve (H) is designed to fit the pump and no adjustment or mechanical settings are necessary.

Q. How is frictional heat removed from the stuffing box cavity?

A. The Flexibox circulating type gland (C) provides product flow directly at the sealing faces.

Let Sealol Engineers solve *your* sealing problems on pumps, agitators, mixers and compressors. Request Bulletin No. 10.

SEALOL

THE BALANCED PRESSURE SEAL

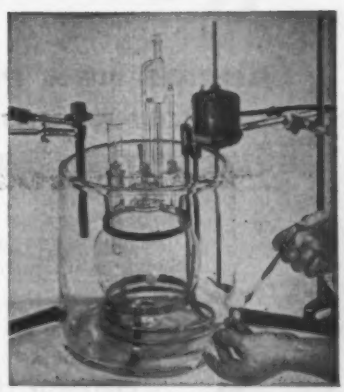
SEALOL CORP
185 Post Road, Providence 5, R. I.

Baton Rouge • Chicago • Cleveland • Corpus Christi • Houston • Los Angeles
New Orleans • New York • Philadelphia • San Francisco • Toronto and Montreal, Canada • Flexibox Ltd. Manchester (Eng.) • Japan • Paris • Frankfurt

NEW VAPOR EQUIVALENT APPARATUS

ACCURATE, QUICK VAPOR APPARATUS OF LP RESIDUES AND OTHER LIQUID ORGANIC SAMPLES

A new instrument which measures volume of vapor produced by a unit volume of liquid. Also determines molecular weights by an adaptation of the Victor Meyer method. Vapor equivalent determinations can be made of residues from natural gas samples, or of any liquid with a vapor pressure of more than 4mm. at the temperature of the vaporization bulb. Unit is compact, mounted within a glass constant temperature bath. Unit consists of a vaporization bulb with an integral multiplying manometer and a removable sample entry system consisting of an orifice and matching pycnometer. Bath is equipped with an electric heater.



cenco

The most complete line of scientific instruments and laboratory supplies in the world

RS

REFINERY SUPPLY COMPANY
621 EAST FOURTH STREET • TULSA 3, OKLAHOMA
2215 McKINNEY AVENUE • HOUSTON 3, TEXAS

CENTRAL SCIENTIFIC COMPANY
1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS
CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO
SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA

For more data on advertised products, use Readers' Service Cards, last page.

the KEMCO code:

TOP QUALITY

SPECIFICATIONS MATCHED EXACTLY

PROMPT DELIVERY

KEMCO

BUILDS NEW PLANT TO PROVIDE EVEN BETTER SERVICE

Due to steadily increasing business, Krueger Engineering & Manufacturing Co. (KEMCO) found it necessary to build a larger plant and add new equipment.

We at KEMCO wish to thank our long list of regular customers for making this plant possible . . . and to them and everybody else interested in heat transfer equipment we extend a cordial invitation to see our new facilities.

KRUEGER ENGINEERING & MANUFACTURING CO.

2001 HIRSCH RD. · P. O. BOX 11286 · HI 2-2537 · HOUSTON, TEXAS

panies were cited by the council for exceptional service in 1956. They are: Clark Oil & Refining Corp.; Esso Standard Oil Co.; Ethyl Corp.; Hedges Oil Co.; Phillips Petroleum Co.; Shell Oil Co.; Sinclair Refining Co.; and Standard Oil Co. (Ind.)

The eight petroleum companies contributed time and space in many advertising media for the promotion of accident prevention. Contributions included radio and television spot announcements, outdoor advertising, newspaper and magazine advertisements, and the sponsoring of safety film showings.

The National Safety Council has awarded The Ohio Oil Co. Refining department a first place for accident prevention in 1956. Competing with other refining departments with under 3 million man hours worked, Ohio Oil won the award for the second straight year.

This year's award represents over 1,446,000 man hours worked without disabling accidents. It is the fourth such award won since 1950.

Changing Times

House armed services committee has introduced a bill that will **authorize Navy to spend $13.5 million within next six years to produce synthetic fuels** from oil shale at Rifle, Colo.

Tiny country of **Jordan has signed agreement with Caltex and Mobiloil** for supply of gasoline and kerosine from Medreco refinery near Sedon. **Negotiations are also in progress** for the supply of diesel oil.

Socony Mobil paid $41,410 in suggestion awards to employes during 1956, an increase of $5000 over previous year. More than 2000 employes—**one out of every ten**—submitted suggestions during year.

Gasoline and oil marketers invested total of **$32,357,000 in national newspaper advertising** in 1956. This figure sets **new all-time high** and represents a 13 percent increase over 1955.

Employes of Leonard division, Leonard Refineries, Inc., overwhelmingly **rejected unionization** by three to one in NLRB election.

Chemstrand Corp. has reached agreement with Societa Edison, Milan, for **manufacture of acrylic fibres in Italy by a newly formed subsidiary** of Societa Edison. Fibre output will begin within two years.

To regulate petrochemical industry development, Brazilian National Petroleum Council has said in the event of a shortage

TWO SUPERIOR SHEET PACKINGS . . . .

for petrochemicals
Belmont TEFLON*

Inert to all chemicals (excepting molten alkali metals and fluorine at elevated temperatures).

Available in sheet thicknesses from 1/32" up, and in sheet sizes from 24" by 24" to 48" by 48". Tape is available in continuous rolls in thicknesses from .005 up and in widths up to 12 inches.

Cut gaskets to specification and envelope gaskets with compressible filler materials for all standard pipe flanges. Write for catalog.

*du Pont Trademark

for oils and solvents
Belmont NEOPRENE

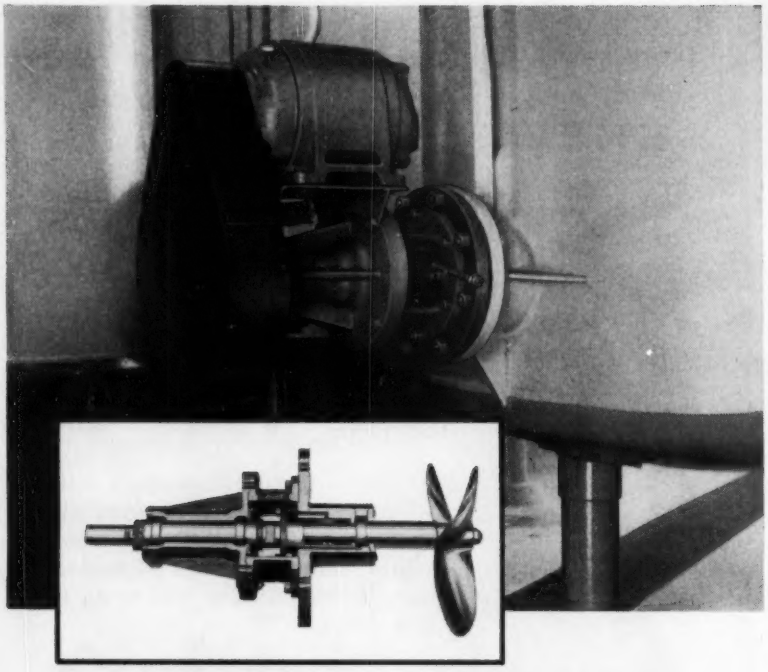
Belmont Neoprene sheet packing has high resistance to petroleum products, alcohol, caustics and many acids. It has high tensile strength and has good abrasion resistance.

Available in standard rolls, 40" wide by 10 yards long, in thicknesses from 1/32" to 1/4" inc. and in durometer hardness of 40, 50, 60, 70, 80 and 90. Also available in cut gaskets.

ask your BELMONT Distributor
Such leading Packing Distributors as:
Mill & Industrial Supplies, Inc. in Louisville
and
Sterling Rubber Products Co. in Dayton
are ready to serve you promptly and helpfully, wherever you are.

Write for Catalog 56.
The Belmont Packing & Rubber Co.
Butler & Sepviva Sts.,
Phila. 37, Pa.

BELMONT



Use Existing Tankage More Effectively . . . with Agitation Engineering and Equipment by NETTCO!

Benefit from application engineering skills acquired in developing the most complete agitator line available today. Be sure your fluids are mixed or blended to complete uniformity . . . in the shortest possible time . . . by equipment specifically designed for your particular job. Check some of the design features found on Nettco's SIDE DRIVE agitator line!

NETTCO "Engineered Agitation" design features . . .

- **Mechanical seals minimize maintenance; make any maintenance required simple, quick, and inexpensive.**
- **Designs permit seal inspection and service under full tank pressure.**
- **Oversize bearings fully enclosed, widely spaced, mounted outside tank — provision for automatic running-position realignment.**
- **Models available in 1/3 to 30 HP sizes; belt driven, chain driven, gearmotor driven, or direct motor driven to suit requirements.**
- **Mechanical seals (with replaceable elements) completely interchangeable with conventional stuffing boxes.**

Send your process specifications to NETTCO agitation engineers for recommendations. Request Bulletin 532 for data on the variety of sizes, motor mounts, speed reduction designs, and stuffing box modifications available. Write now! New England Tank & Tower Co., 81 Tileston Street, Everett 49, Massachusetts.

NETTCO

ENGINEERED AGITATION SPECIALISTS

FREE LITERATURE

Please send me the following literature:

- ☐ **Tank Top Agitators—Bulletin 551**
- ☐ **Portable & Tripod Mixers—Spec. Sheets**
- ☐ **Pipeline-Flomix®—Bulletin 531**
- ☐ **Side Entering—Bulletin 532**

What's Happening . . .

of raw materials, **foreign or partly foreign-owned companies** may be given less **favorable treatment** than wholly Brazilian-owned companies.

Sunray Mid-Continent Oil is now introducing new premium gasoline in Midwestern and Southern states. Known as "D-X Boron Lubricating Fuel", **gasoline contains a boron additive.** Tests show fuel has actual "road octane number" of 99.

Esso Standard Oil Co. has established new highway traffic department. Sponsorship of highway-safety, research, education, enforcement, and engineering projects will be major part of overall program.

U. S. government has postponed "until further notice" the sale of 75 percent of its controlling interest of General Aniline & Film . . . **for the first time in company history, a woman** has been elected secretary of Standard Vacuum Oil Co. . . . in event of "an extreme national emergency" **shale oil might be needed immediately** says Union Oil researcher. . . . **National Distillers Products Corp. has changed its name to** National Distillers and Chemical Corp.

Changes In Ownership

Plymouth Oil Co. has become the sole owner of Republic Oil & Refining Co. Hereafter, Republic will operate as a division of Plymouth. This is a further step in an integration which began last year when Big Lake Oil Co. was dissolved and its assets and operations were transferred to Plymouth.

Dow Chemical Co. has purchased 50 percent interest in Sales y Alcalis, S.A., a Mexican concern situated near Coatzacoalcos. Sales y Alcalis owns extensive salt mining rights in the state of Vera Cruz on the Tehauntepec isthmus. The mining site, comprising several hundred acres, was purchased as a location for future manufacturing operations involving caustic soda and other alkali derivatives, chlorine, and related products.

All of the capital stock of Triangle Refineries, Inc., Houston, is being acquired by Kerr-McGee Oil Industries, Inc., Oklahoma City. Triangle will continue to operate under its same name, as a subsidiary of Kerr-McGee. One of the largest independent marketers of refined petroleum products, Triangle operates in fifteen states, from Wisconsin to Florida.

Two Texas engineering firms, H. E. Bovay, Jr., Consulting Engineers, and Reg F. Taylor, Consulting Engineer, have merged. The Bovay firm name will be retained. The merger is in keeping with the trend of larger more fully integrated firms capable of handling all phases of construction.

How Metallizing saves money in refineries

cuts machine repair costs 80%—
cuts equipment "down-time"—
permits reduced spare parts stocks

Practically any worn machine part—repaired for only 15 or 20% of replacement cost—in minutes and hours, instead of days or weeks.

Pump shafts • Impeller journals
Rotor blades • Packing areas
Motor shafts

Partial list of Metallizing users in the Petroleum industry.

Cities Service Refining Co.
Esso Standard Oil Co.
Gulf Oil Co.
Ohio Oil Co.
Phillips Petroleum Co.
Socony-Vacuum Oil Co.
Imperial Oil Co. (Canada)

Write today for further information or a call by a full-time, company-trained Metco field engineer in your territory.

METCO

Metallizing Engineering Co., Inc.
1157 Prospect Ave., Westbury, L. I., New York • cable: METCO
In Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England

WHEN SPECS CALL FOR...

HEAT EXCHANGERS

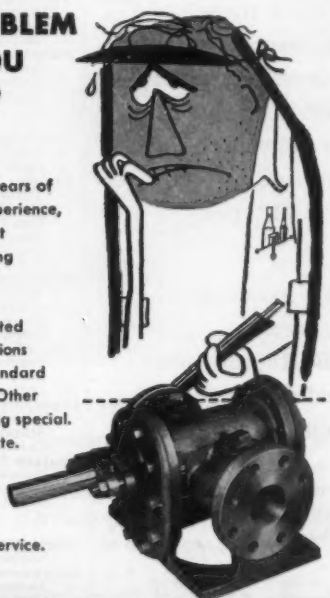
custom fabricated on the West Coast

Save on transportation costs, manufacturing time and put yourself in a more competitive position by contacting an experienced "on the spot" source when planning the procurement of process and plant equipment for the West Coast. Send prints for prompt quotation on your next job.

Request Brochure No. K-57

PS F SINCE 1900
PUGET SOUND FABRICATORS, INC.
Craftsmen in Metals
3670 E. Marginal Way • Seattle 4, Wash.
Craftsmen in steel plate and alloys up to 1"

PUMPING PROBLEM GIVING YOU TROUBLE?



Get *qualified* help.
Tell us about it.
SK Gear Pumps, product of years of research and engineering experience, are solving problems in almost every industrial field—pumping many types of materials like alcohol, fuel oils, glue, wax, lube oils, resins, cellulose, heated oils, road tars. Some applications require only a top-quality standard pump. Ours are top-quality. Other applications demand something special. If so, we're ready to cooperate.

We'd like to get acquainted —let us send you Bulletin 17-A describing our pumps and engineering service. Just write us. We'll send it.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2257 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 18-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

VIKING ROTARY PUMPS

• **Cut-Away View Showing Viking's Gear-Within-A-Gear Principle**

The unique and unusually simple construction of Viking Pumps . . . with only two moving parts . . . assures you of long, easy-maintenance operation with all grit-free liquids.

Let Southern Engine & Pump Company show you how Viking Pumps can solve your pumping problems. We invite your inquiries.

Distributors
SOUTHERN ENGINE & PUMP COMPANY
MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS
Service Facilities at: Houston–Dallas–Kilgore–San Antonio–Edinburg
Corpus Christi and Beaumont, Texas

These BS&B Rupture Discs Can Give Your Pressured System...

Standard Rupture Discs, prebulged... available in a broad range of sizes, pressures and metals.
Vacuum Supports . . . installed under prebulged rupture discs to prevent their collapse under vacuum; fit exact disc contours.
Plastic Linings . . . and coatings for protection of prebulged discs under any specific corrosive condition.
Model D & DV Rupture Discs . . . for high temperature, pulsating pressure and corrosive services. Model DV includes vacuum support.
Model 1A & 1B Rupture Discs . . . for lower rupture pressures than prebulged discs; excellent for corrosive services. Model 1B includes flat vacuum support.

Positive Pressure Protection From 3 To 50,000 PSI

Installing a BS&B Rupture Disc on a pressured system provides protective insurance against a major disaster. Thousands of BS&B Safety Heads, each containing a BS&B Rupture Disc custom made to meet the individual requirements of the system it protects, are now guarding pressured systems in all types of industries.

Fully accepted by most local and national codes for use as either primary or secondary pressure relieving devices, BS&B Rupture Discs can be *your* positive and final measure of protection for the unexpected emergency.

THE "CIRCUIT BREAKER" of Pressured Systems

Why not talk it over with your BS&B Representative . . . or write for further information to . . .

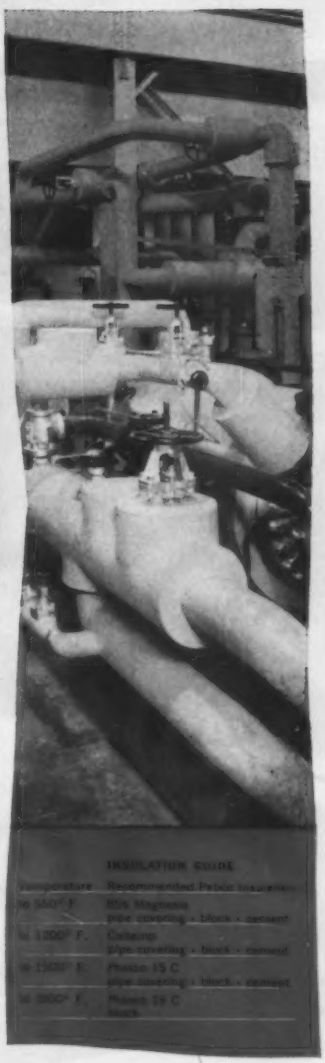
BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-F5
7500 East 12th Street
Kansas City 26, Missouri

MEETINGS CALENDAR

MAY	
19–23	The American Society for Mechanical Engineers, Oil and Gas Power Conference, Kentucky Hotel, Louisville, Ky.
20–23	Second Design Engineering Show, New York Coliseum, New York.
20–24	National Fire Protection Association, 61st Annual Meeting, Hotel Statler, Los Angeles.
22–24	American Institute of Chemists, Inc., 34th Annual Meeting, Sheraton-Mayflower Hotel, Akron, Ohio
23–24	Western Petroleum Refiners Association, Southwest Regional Technical-Industrial Relations Meeting, Hotel Paso del Norte, El Paso, Texas.
27–28	Chemical Market Research Association, Annual Meeting, Hotel Plaza, New York City.
JUNE	
6	Pennsylvania Grade Crude Oil Association, 34th Annual Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.
9–12	American Institute of Chemical Engineers, Olympic Hotel, Seattle, Washington.
9–13	Fourth International Automation Exposition and Congress, New York Coliseum, New York City.
10–28	Summer Session on Natural Gas Technology, includes Natural Gas Production and Processing, and Natural Gas Distribution, Institute of Gas Technology, Chicago.
14–16	The American Society of Mechanical Engineers, Semi-Annual Meeting, Sheraton-Palace, San Francisco.
16–21	American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N.J.
18–19	Rocky Mountain Oil and Gas Association, Annual Meeting of Refining Committee, Northern Hotel, Billings, Mont.
19–21	Twelfth Annual Meeting for Association for Computing Machinery, University of Houston.
20–21	Western Petroleum Refiners Meeting, Mid-Continent Regional Technical-Industrial Relations Meeting, Broadview Hotel, Wichita, Kan.
24–28	American Institute of Electrical Engineers, 1957 Fall General Meeting, Sheraton-Mt. Royal Hotel, Montreal, Canada.
26–29	American Association of Cost Engineers, First Annual Meeting, University of New Hampshire, Durham, N.H.
JULY	
8–19	Short Course in Industrial Statistics for Process Industries, University of Oklahoma, Norman.
8–26	Summer Session on Natural Gas Technology, includes Natural Gas Transmission, and Natural Gas Fuel Utilization, Institute of Gas Technology, Chicago.
AUG.	
7– 9	Sixth Annual Conference on Industrial Applications of X-Ray Analysis, Metallurgy Division, Denver Research Institute, University of Denver.
11–15	American Society of Mechanical Engineers, Heat Transfer Conference, Pennsylvania State College, University Park, Pa.
19–21	Cryogenic Engineering Conference, host will be National Bureau of Standards in Boulder, Boulder, Colo.
28–30	Analysis Instrument Committee's International Symposium on Gas Chromatography, Kellogg Center, East Lansing, Mich.
SEPT.	
8–13	American Chemical Society, 132nd National Meeting, New York City.
9–13	Instrument Society of America, 12th Annual Instrument Automation Conference and Exhibit, Cleveland Auditorium, Cleveland.
11–13	National Petroleum Association, 55th Annual Meeting, Traymore Hotel, Atlantic City, N.J.
15–18	American Institute of Chemical Engineers, Lord Baltimore Hotel, Baltimore.
22–25	The 12th Annual Petroleum Mechanical Engineering Conference, Mayo Hotel, Tulsa.
23–25	American Society of Mechanical Engineers, Fall Meeting, Statler Hotel, Hartford, Conn.

Complete control
of temperatures with
PABCO
PRECISION-MOLDED
CALTEMP
a Calcium Silicate
Insulation



Name your temperature. A performance-proved Pabco pipe or block insulation will maintain it at economical levels up to 1900° F. With Pabco Caltemp, 85% Magnesia, or Prasco Insulations, heat losses are reduced to an absolute minimum . . . finest performance assured. For data on technical advantages, case histories, or engineering consultation . . . write . . . or contact one of Pabco's insulation engineers.

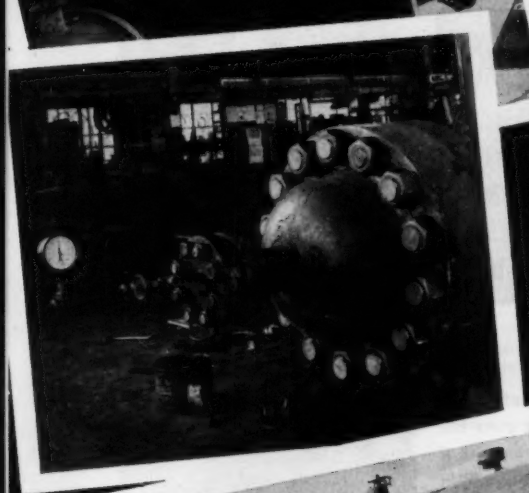
PABCO **INDUSTRIAL INSULATIONS DIVISION**

Fibreboard Paper Products Corporation • San Francisco 19 • Chicago 54 • Houston 4 • New York 16 • Los Angeles

For more data on advertised products, use Readers' Service Cards, last page.

HEAT EXCHANGERS

FOR THE PETROLEUM, CHEMICAL, AND PROCESS INDUSTRIES



DESIGN • REPAIR • FABRICATION

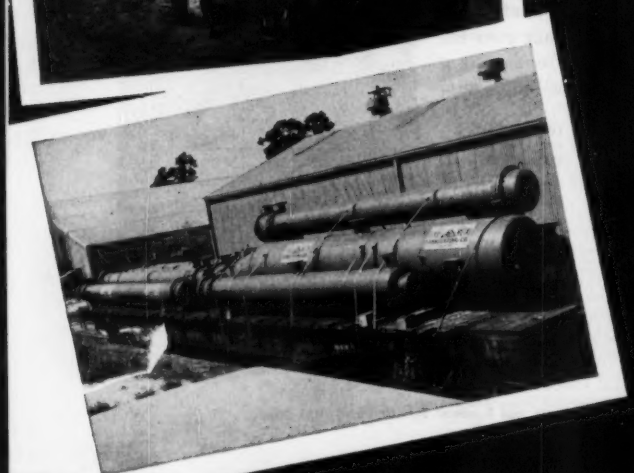
Your inquiries are cordially invited.

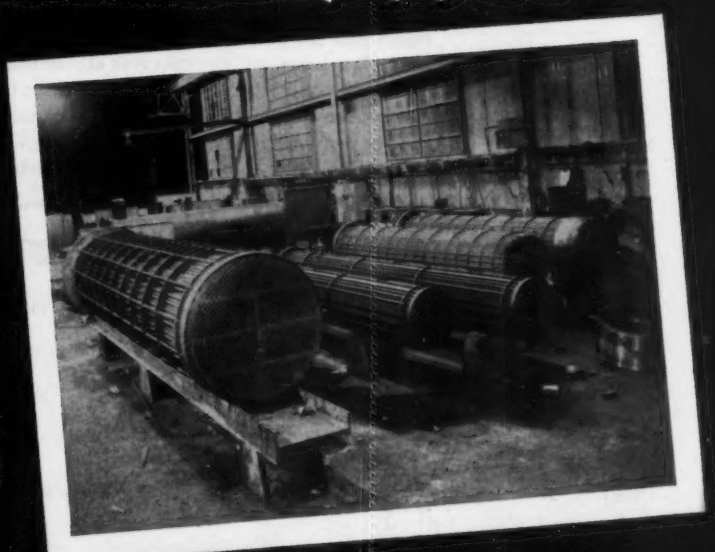
MTF

TEXAS METAL FABRICATING CO.

BOX 7567 - HOUSTON 7, TEXAS

API-ASME AND ASME CODE CONSTRUCTION





What's Happening . . .

. . . *Among Men* in the Industry

WPRA Presents Hanlon Award To Sun Oil's Charles Webber

The Hanlon Award, highest honor in the natural gasoline industry and one of the ranking awards of the petroleum industry, was presented April 25 to Charles E. Webber, technical advisor to the vice president, Sun Oil Co., Philadelphia. The ceremony took place at the 36th annual convention of the Natural Gasoline Association of America held at the Rice Hotel, Houston.

Webber is the 21st recipient of the Hanlon Award which is conferred annually by the NGAA for outstanding service to the natural gasoline industry. Donor of the award is E. I. Hanlon, chairman of the board, National Bank of Tulsa, and a pioneer of the Natural Gasoline Industry.

Presentation was made by NGAA President A. H. Weil, United Gas Pipe Line Co., Shreveport. The citation read in part: "In making this presentation, we are specifically recognizing his valuable service to the industry in times of national crisis, his personal contributions to the technology of natural gasoline operations, and his stimulating and constructive leadership in cooperative group activities which speeded progress toward desired and greatly needed technical objectives."

Charles E. Webber

Webber was born in Stillwater, Okla., but grew up in Pittsburgh, Pa., and Baton Rouge, La. He went to Louisiana State University where he obtained a B.S. degree in 1932, and an M.S. degree in 1934, both in chemical engineering. Following graduation he become a chemist for Humble Oil & Refining Co., Houston; he also served in the company's Natural Gas department in East Texas. He returned to Houston in 1939 where he did experimental work which led to the publication of his paper "Equilibrium Constants for Hydrocarbons in Absorption Oil," presenting data which is still useful in the design of high pressure absorbers.

In June 1942 he was given a leave of absence by Humble to go to Washington where he served on the staff of the Natural Gasoline division of the Petroleum Administration for War. At the close of the war he became assistant to the late James E. Pew, Sun Oil Co., Philadelphia, in the operation of that company's natural gas division. He returned to Washington in 1951 as director of the Natural Gas Production and Processing division of the Petroleum Administration for Defense. The following year he returned to Philadelphia but still commutes to Washington as a member of the Military Petroleum Advisory Board. He assumed his present position in 1955.

J. J. Donovan, formerly associate research chemist, was named project director of Houdry Process Corp.'s laboratories at Linwood, Pa.

Also, **W. S. Briggs** and **G. Talvenheimo,** assistant research chemists I, became associate research chemists.

J. E. McEvoy was promoted from assistant research chemist II to assistant research chemist I.

James F. Grutsch has been appointed by Standard Oil Co. (Indiana) as group leader in the heavy oils, asphalt and ammonia technical service division of the research department at Whiting, Ind.

Franklyn M. Moffitt was elected a vice president of the Ashland Oil & Refining Co., Ashland, Ky., at the board of directors meeting following the annual stockholders meeting. He had been national account sales manager, and in his new capacity will have charge of sales of aviation fuels, railroad and industrial fuels and lubricants, petro-chemicals and other petroleum specialties.

Moffitt joined Ashland in January 1940, becoming successfully a terminal manager, salesman, manager of Light Oil Sales, and appointed national account sales manager in 1952. He graduated from Duke University in 1938.

Julian A. Rogers has been appointed head of the Manufacturing department of W. R. Grace & Co.'s Polymer Chemicals division high density polyethylene plant in Baton Rouge, La.

Rogers was formerly head of the ammonia department of Grace Chemical Co. in Memphis, Tenn., where he recruited and trained operating personnel. He also was responsible for the start-up operations of Grace's ammonia plant and continued as department head for the first three years of production of the plant.

Rogers attended Peabody College and Southern Methodist University where he studied mechanical engineering. He is a member of the American Institute of Chemical Engineers and the Armed Forces Chemical Association.

Prior to joining Grace, Rogers was ammonia plant superintendent of Mississippi Chemical Corp. from 1950 to 1952.

Theodore A. Burtis has been re-elected president of Houdry Process Corp. Stockholders also re-elected all members of the corporation's board of directors. They are Burtis; vice presidents George H. Daft, Jack C. Dart, Robert J. Mawhinney, Alex G. Oblad and Claude C. Peavy; John D. M. Hamilton, secretary; and Van Horn Ely, Jr., Chalmer G. Kirkbride and Pierre Quilleret.

O. N. Miller has been appointed a vice president of Standard Oil Co. of California. Miller has been a vice president of Standard Oil Co. of California, Western Operations, Inc., the Company's operating subsidiary in the seven Western states, Alaska and Hawaii.

Miller

Miller joined Standard in 1934 and he served as general manager of Standard's Manufacturing department for eight years, from 1946 to 1954. His experience covers both the research and refining fields, including planning and design of the Ras Tanura Refinery in Saudi Arabia.

He is a graduate of the University of Michigan.

Bruce Lintner and **Harold Hobbs** were elected officers of Delhi-Taylor Oil Corp. They will replace former secretary and treasurer **S. B. Petrie,** who has been appointed management consultant on financial affairs. Petrie has many years experience in the oil and gas industry.

As treasurer of the company, Lintner is responsible for the accounting, purchasing, personnel-office services and systems-procedures departments. Lintner joined Delhi Oil Corp. as Petrie's assistant shortly after

Men in the Industry . . .

graduating from the University of Texas in 1949. He was appointed assistant chief accountant at the time of the Delhi-Taylor merger.

Harold Hobbs, new Delhi-Taylor secretary, is in charge of corporate affairs, banking and credit matters, employe communications, public relations, shareholder relations, and special staff assignments. Hobbs received a business administration degree from Southern Methodist University in 1949 and joined Continental Oil Co. in Houston as a financial analyst. He was employed as administrative assistant by Delhi-Taylor in July, 1955.

API Refiners Award Certificates of Appreciation to Three

Three well-known oil men were given special honors at the 22nd mid-year meeting of the Division of Refining of the American Petroleum Institute in Philadelphia, Pa.

They were given Certificates of Appreciation in recognition of long and meritorious service with the Institute and its committees, and of their contributions to petroleum technology.

Recipients of the Certificates of Appreciation this year were **D. P. Barnard,** research coordinator for Standard Oil Co. (Indiana), Chicago; **Hugh W. Field,** vice president and general manager of research and development, Atlantic Refining Co., Philadelphia; and **Dr. J. Bennett Hill,** pioneer oil chemist and recently retired director of research and development, Sun Oil Co., Marcus Hook, Pa.

W. W. Lowe, vice president of Cities Service Petroleum, Inc., has been elected to the board of directors of the parent Cities Service Co.

Lowe

Lowe is also a director of Cities Service Refining Corp. and of Cities Service Research and Development Co., as well as president of the Wolverine Pipe Line Co.

A native of Wartrace, Tenn., he started his career with Cities Service in 1912, following graduation from the University of Tennessee as an electrical engineer. He went to New York in 1921 as assistant chief technologist and, four years later, was appointed chairman of the manufacturing committee in charge of refinery operations. He has been a vice president and director of Cities Service Petroleum, Inc., since 1946.

A member of the Society of Automotive Engineers and the American Petroleum Institute, Lowe resides in Mountainside, N. J.

David R. Breien has been elected vice president-comptroller of The Lummus Co., New York. Others elected at the same time were **M. J. Marchione** as treasurer and **C. Frank Corbin** as assistant secretary.

With Lummus since 1934, Breien formerly held the post of secretary-treasurer. In addition to his new post, he retains the position of Company Secretary.

Marchione, formerly a partner in the accounting firm of Hackeling, Oberkirch, Corbin and Co., joined Lummus in 1952. He was elected assistant treasurer in 1953, and assistant secretary-treasurer in 1955.

Corbin joined Lummus in 1955 after being a partner in Hackeling, Oberkirch, Corbin and Co. Both he and Marchione are members of the American Institute of Accountants and are New York Certified Public Accountants.

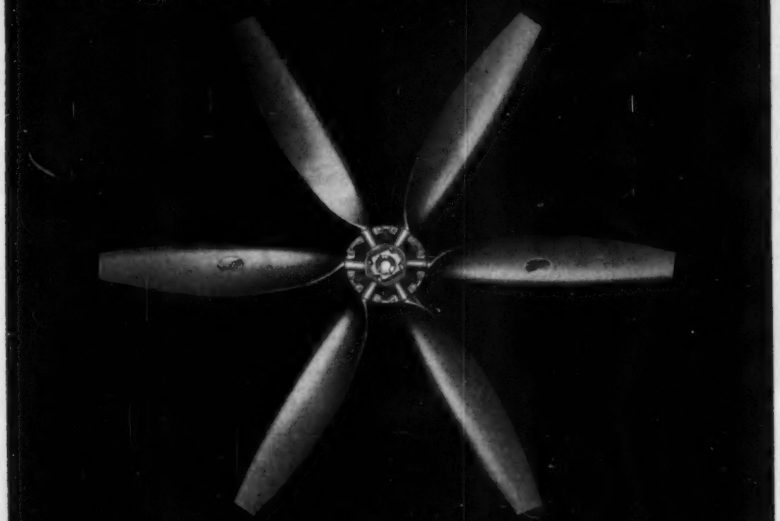
George J. Gregor, Dallas, has been elected a member of the board and vice-president in charge of marketing of Magnolia Petroleum Co. Also elected to the board were **R. G. Sanders,** Beaumont, also named vice-president and manager of refining; **Charles B. Wallace,** Dallas, who also becomes a vice-president in addition to his present duties as general counsel; and **L. H. True,** Dallas.

The new directors were given their posts at a stockholders' meeting held in Dallas.

Gregor will succeed **Guy L. Tate,** vice-president in charge of marketing, who retired April 1. Gregor joined Socony Mobil Oil Co., Inc., in 1922. He progressed through positions until he was transferred to Magnolia, Socony Mobil's southwestern affiliate, May 1, 1956, as assistant to Tate.

Succeeding **John W. Newton,** Beaumont,

HARTZELL All-Aluminum
Cooling Tower and Heat Exchanger Fans



stand up under the toughest operating conditions

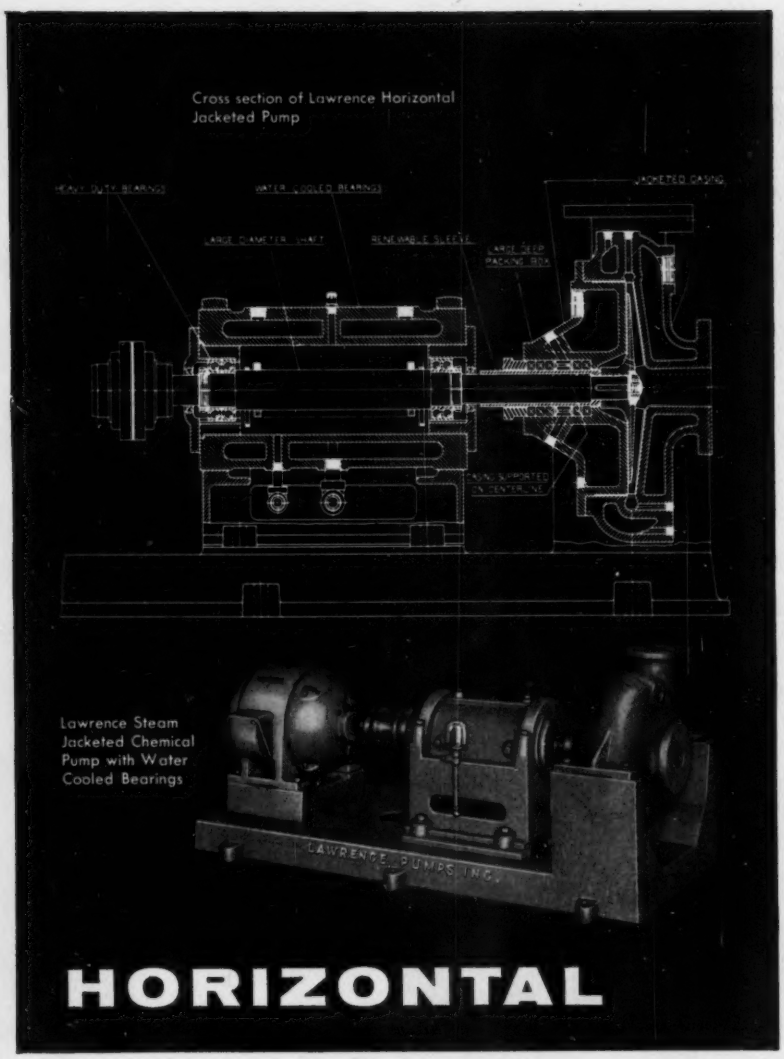
- Hub and blades are precision-finished aluminum-alloy castings. Cast aluminum construction combines high strength with exceptional resistance to corrosion.
- Blade shanks are threaded to fit threaded blade housings cast into hub. Blades may be turned to change pitch by merely loosening two bolts.
- Because all hubs are dynamically balanced and all blades balanced against a master blade, damaged blades may be replaced in the field without destroying the balance of the assembly.
- Eleven sizes, 40" to 132" diameters; 3, 4 and 6 blade assemblies.
- For complete details, call your nearby Hartzell field engineer or write for your free copy of new Bulletin A-111B.

Hartzell Propeller Fan Company
Div. of Castle Hills Corporation
809 Thomas Blvd. Piqua, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

With refinery men it's
Davison Catalysts because
● Davison gives you quality
● Davison gives you service
● Davison catalysts save you money
Progress Through Chemistry
DAVISON CHEMICAL COMPANY
Division of W. R. Grace & Co.
101 North Charles Street, Baltimore 3, Maryland
Sales Offices: Chicago, Ill.; Houston, Texas; New York, N.Y.; Baltimore, Md.; San Francisco, Calif.
In Canada: Davison Chemical Company Ltd., Toronto
Producers of: Catalysts, Inorganic Acids, Superphosphates; Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizers.

For more data on advertised products, use Readers' Service Cards, last page.



jacketed PUMPS

Lawrence jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc., which tend to solidify or become viscous at low temperatures. The heating medium can be steam, dowtherm, etc., and all heating spaces are vented and self-draining.

The bearings are heavy-duty, water-cooled. Misalignment and distortion, which might be caused by thermal expansion, are eliminated by supporting the casing along the center line of the shaft.

If you have to pump liquids which must be held above a specified temperature to retain their fluidity, write us the pertinent details. No obligation.

Write for Bulletin 203-7.

LAWRENCE PUMPS INC.
371 Market Street, Lawrence, Mass.

Men in the Industry . . .

who retired May 1 as vice-president and manager of refining, will be R. G. Sanders, an assistant manager of the Refining division since January, 1938. Sanders graduated from Georgia Tech in 1919 with a B.S. degree in electrical engineering, then started work with Magnolia in September, 1920. He became chief engineer of the Refining division in 1928, and then executive assistant in 1936.

A native of Shelby County, Texas, Charles B. Wallace attended the University of Texas and received his law degree from Southern Methodist University. He joined Magnolia's legal staff in April, 1939, was placed in charge of litigation for the company in 1951, and was named general counsel on July 1, 1956.

Also taking a directorship of the petroleum company is L. H. True, who has served as president of Magnolia Pipe Line Co. since March 11, 1952. A veteran of pipe line operations, True joined the company in December, 1921. On January 1, 1946, he was appointed manager of pipe lines, a position that preceded his presidency of the company.

Magnolia Petroleum also announced the appointment of two assistant vice-presidents: **M. W. Patterson** and **E. J. Wacker, Jr.**, both of Dallas. In addition, **Fred H. Pennington**, Dallas, was elected treasurer of the Company.

Brisco

Espinosa

Milo M. Brisco was proposed to the shareholders of International Petroleum Co., Ltd., for election to the company's board of directors at the annual meeting held in Toronto on May 9. At a special general meeting on the same day, shareholders also voted on a proposal to increase the number of directors from eight to nine.

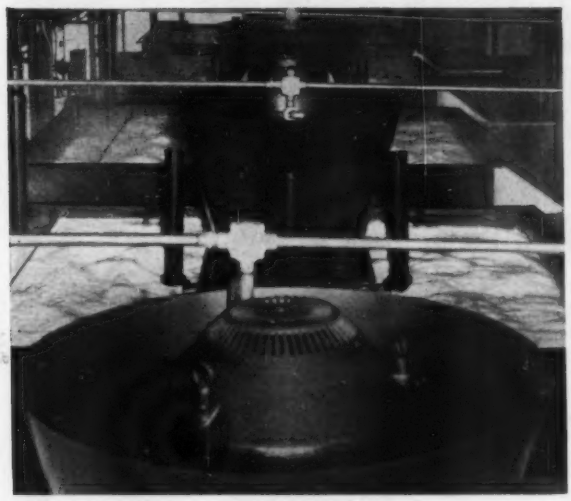
At the present time, Brisco is International's executive representative in Colombia, a post which will be assumed on June 1 by **Fernando J. Espinosa.**

Brisco has been associated with International and its subsidiaries in Peru and Colombia since 1935. In 1951 he was appointed assistant general manager of International Petroleum (Colombia) Ltd., transferring to Lima in 1953 to become assistant general manager of International in Peru. Later the same year, Brisco was named general manager, remaining in that position until 1955, when he returned to Colombia as International's executive representative there. Brisco will join International's Executive Office in Coral Gables, Fla., about mid-August.

Espinosa studied at the University of Havana and the University of Florida, receiving a B.S. degree in business administration from Florida University in 1933.

HENDRICK HYDRO-DEHAZER

removes haze from refinery oils in a hurry!



Here's a process that has been operating with a great deal of economy in several major refineries: The Hydro Dehazer's huge rotor mixes moisture-laden oil with free air until the moisture is absorbed by the air and discharged to atmosphere. The entire cycle achieves optimum efficiency without the use of compressed air, high heat, chemicals or other additives. Capacities range to 450 bph for No. 2 fuel oil at an inlet temperature of 130°F. with a haze point of 70° depending on the consistency of the charge.

HENDRICK MANUFACTURING COMPANY
36 Dundaff Street, Carbondale, Pennsylvania

Gentlemen:

I am interested in learning more about the new Hendrick Hydro Dehazer.

☐ Please send technical data.

☐ Please arrange demonstration of the Dehazer Pilot Model.

Name_____ Title_____

Company_____

Street_____

City_____ Zone____ State_____

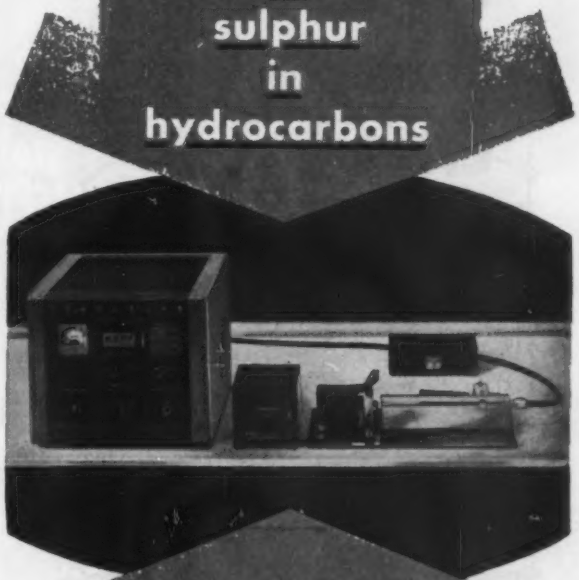
Hendrick
MANUFACTURING COMPANY
36 DUNDAFF STREET, CARBONDALE, PA.
Sales Offices In Principal Cities

Perforated Metal • Perforated Metal Screens • Wedge Slot and Wedge Wire • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrix Hydro Dehazer • Petrochemical Column Internals

SEE OUR CATALOG IN THE COMPOSITE CATALOG

fast! simple! accurate!

determination of sulphur in hydrocarbons



Tracerlab's sulphur determination apparatus enables you to use the fastest method to determine accurately the sulphur content of hydrocarbons such as fuel oil and gasoline. With this new Tracerlab equipment, unskilled operators can determine sulphur content quickly, easily, precisely. Hence, sulphur determination can now be put on a wholly routine basis.

No longer is it necessary to employ complex X-ray diffraction apparatus and highly skilled, technically trained operators. The new Tracerlab equipment is compact, rugged and can be conveniently used in the field or the refinery with no need for a controlled laboratory environment. It operates on the principle of selective absorption of low energy radiation from an isotope source.

The equipment is low in first cost and can be completely amortized over a short period. Your inquiries are invited. Send for Bulletin P-104.

Tracerlab
1601 Trapelo Road • Waltham 54, Mass.
2030 Wright Avenue • Richmond, California
Offices in principal cities throughout the world.

For more data on advertised products, use Readers' Service Cards, last page.

How to IMPROVE Catalytic Cracker PERFORMANCE

YORKMESH DEMISTERS in Vacuum Towers effectively remove entrained asphalt to provide clean gas oil. The improved catalytic cracker charging stock with decreased carbon and metal contaminants results in —

HIGHER THROUGHPUT rates due to reduced load on the regenerator;

HIGHER YIELDS of liquid products due to high catalyst activity maintained for longer periods.

York engineers will review your operating conditions and recommend the best Demister from the several styles available, which include the new "Triple H" high-efficiency, homogeneous, herringbone Yorkmesh Demister.

WRITE for Bulletin 18 and Case Studies 1001, 1002 and 1004 from our technical library for specific information on vacuum tower installations.

YORK

OTTO H. YORK COMPANY, INC.
6 Central Avenue, West Orange, N. J.

Specialists in **FLUIDS SEPARATION / ENGINEERS and MANUFACTURERS**

Men in the Industry . . .

Until 1946 he held various positions in the fields of economics and economic research with state and federal agencies, except for a period of service with the Air Force during World War II.

After being associated for a short time with an importing firm in Colombia, Espinosa joined the financial staff of a subsidiary of International in 1947. In 1951 he was named general manager of Esso Colombiana S. A., International's marketing subsidiary in Colombia. In 1956 Espinosa was appointed the company's assistant executive representative in Colombia, as well as general manager of International Petroleum (Colombia) Ltd.

Alfred R. Smith has joined Scientific Design Co., Inc., New York, as assistant to the vice president, new project development. Smith was formerly assistant to the executive vice president of Chemical Construction Corp., and was associated with that organization for 16 years. More recently, and just prior to his joining SD, he was a director of Sharples Chemical and Industrial Ltd., Nassau, Bahamas.

Smith

Orr

Cash

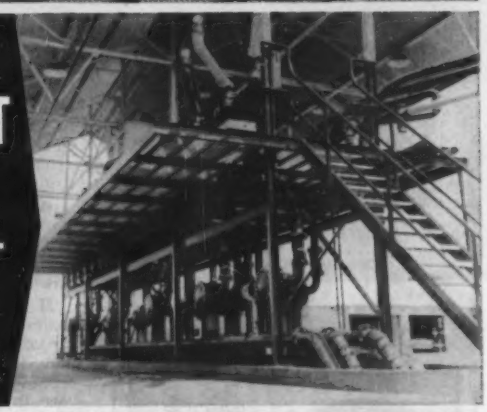
William P. Orr has been made assistant general manager of the Plastics division, Celanese Corp. of America. Prior to this, Orr served as plant manager of the new Celanese polyolefin plastic plant which recently went into commercial production at Houston.

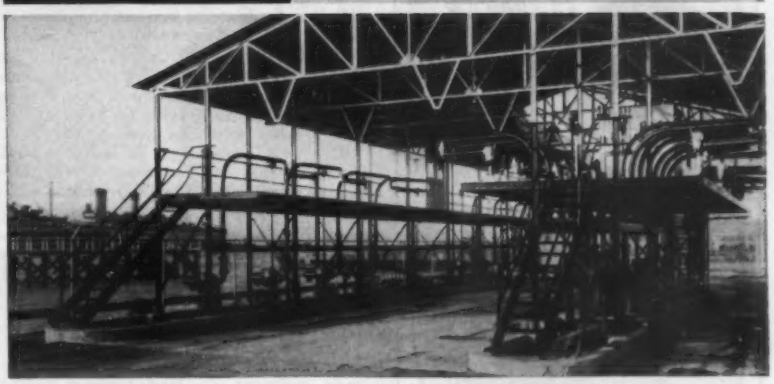
He joined Celanese in 1945 as a chemical engineer in process operations at the Bishop, Texas, chemical plant. In 1952, he was made assistant to the Chemical division's plant operations manager and, in 1955, project manager. Transferred to the company's plastics division in late 1955, he served as project manager for construction of the Houston plant and was made plant manager in August 1956.

Orr was born in Kingfisher, Okla. He is a graduate of the University of Oklahoma, where he received his B.S. degree in chemical engineering in 1940.

Burton E. Cash, former assistant plant manager of the Celanese Houston plant, succeeds Orr as plant manager. Cash, a native of Newark, N. J., and a chemical engineering graduate of Syracuse Univer-

Use Safety
GRIP-STRUT
grating
for a safe footing on stairs and platforms

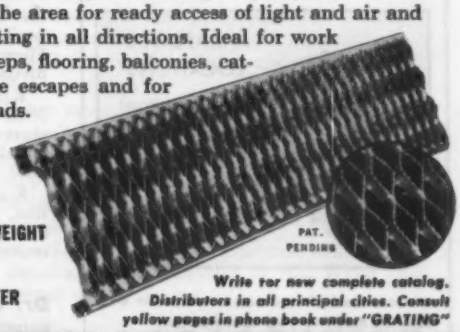




SAFETY GRIP-STRUT is the new basic material, all in one piece (including channels), not welded, riveted or expanded in steel or aluminum, in standard sizes and gauges. Safety GRIP-STRUT presents an open space, in a diamond pattern, in excess of 55% of the area for ready access of light and air and gives a positive NON-SKID footing in all directions. Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

Important Safety Features

- FIRE PROOF
- SLIP PROOF
- MAXIMUM STRENGTH
- MINIMUM WEIGHT
- EASY TO STAND ON
- COOL IN SUMMER — WARM IN WINTER



Write for new complete catalog. Distributors in all principal cities. Consult yellow pages in phone book under "GRATING"

107

GRIP-STRUT

PRODUCTS DIVISION
The GLOBE *Company*
4008 S. PRINCETON AVE., CHICAGO 9, ILL.

For more data on advertised products, use Readers' Service Cards, last page.

MERCOID

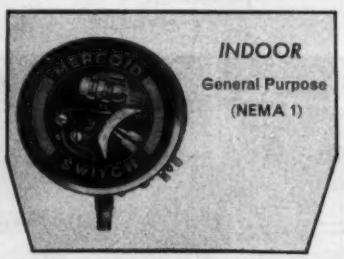
SAFETY CONTROLS

FOR PUMP AND COMPRESSOR STATIONS

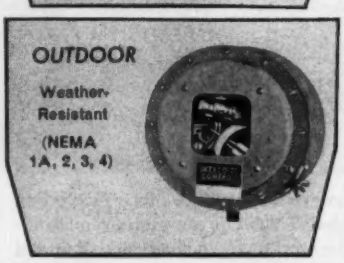
Here are a few of the many functions Mercoid Controls perform in safeguarding major pipeline equipment:

- *High discharge pressure*
- *High case pressure*
- *Low suction pressure*
- *High case temperature*
- *High bearing temperature*
- *Lube oil pressure*
- *Instrument air pressure*
- *Mechanical seal failure*
- *Differential pressure for pressurized control rooms*

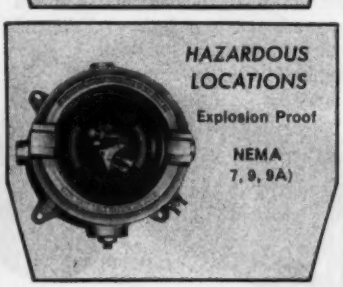
FOR EVERY PURPOSE



INDOOR
General Purpose
(NEMA 1)



OUTDOOR
Weather-Resistant
(NEMA 1A, 2, 3, 4)



HAZARDOUS LOCATIONS
Explosion Proof
NEMA 7, 9, 9A)

Mercoid Controls are also available in steel cabinets made to your specifications

Write for Catalog No. 857

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

Men in the Industry . . .

sity, joined Celanese in 1936 as a development engineer. From 1949 to 1952, he served as technical control superintendent at the Belvidere, N. J., plastics plant when he took over similar duties at Newark. He was made assistant to the Newark plant manager in 1953 and, two years later, became assistant to the Plastics division's plant operations manager. He was transferred to Houston as assistant plant manager in August in 1956.

H. W. Torgeson, Bartlesville has been appointed manager and **H. R. Shepherd, L. G. Brannin** and **C. W. Rohler** assistant managers of the Cities Service Oil Co. refinery at Ponca City, Okla.

The new appointments followed the transfer to new positions of responsibility in the company's headquarters office at Bartlesville of **S. R. McMurry,** Ponca City refinery manager, and of **M. E. Wooldridge,** plant superintendent.

Wooldridge, who has served as plant superintendent the past five years, will head the newly-created operations department in the refining division's headquarters offices in Bartlesville.

H. W. Torgeson joined the company's graduate training school in 1947 and served at Ponca until 1949, when he was moved to Bartlesville. He served on the refining division staff until 1955, when he was appointed staff assistant to Cravens. He is a graduate of Kansas University and holds a B.S. degree in chemical engineering.

Shepherd, who will be assistant manager in charge of personnel, was first employed by Cities Service Gas Co. in 1947, transferring to Cities Service Oil Co. in 1953 as a member of its industrial relations division. At the time of his newest appointment, he was superintendent of labor relations in the industrial relations division.

Brannin is the new assistant plant manager at Ponca City in charge of operations. He joined Cities Service in 1945 and was stationed at the company's Tallant, Okla., research laboratory for four years. He was transferred to Ponca City in 1949 and has served as special engineer, assistant cracking foreman, special operating engineer and was cracking foreman at the time of his latest appointment.

A. R. Kratzberg, formerly general superintendent, has been named manager of Fluor Products Co.'s Metal Fabrication division at Paola, Kan.

Kratzberg, who started with Fluor in 1935 as a welder on construction jobs, succeeds **Clyde W. Hull,** who headed the metal manufacturing activity since 1953. Hull recently resigned.

Kratzberg came to the Paola installation, from construction, in 1940 as assistant superintendent. In 1954, he was promoted to general superintendent.

Dr. Clarence A. Stiegman has been named director of product development of Hooker Electrochemical Co., Niagara Falls, N. Y. In this capacity Dr. Stiegman will direct product development of both the chemical and plastics elements of Hooker's business. He was vice president and technical director of Oldbury Electro-

Thirty Million B.T.U. CAPACITY

NIAGARA
Aero HEAT EXCHANGER

. . . Cooling in Chemical Processes with Precise Control of Temperature

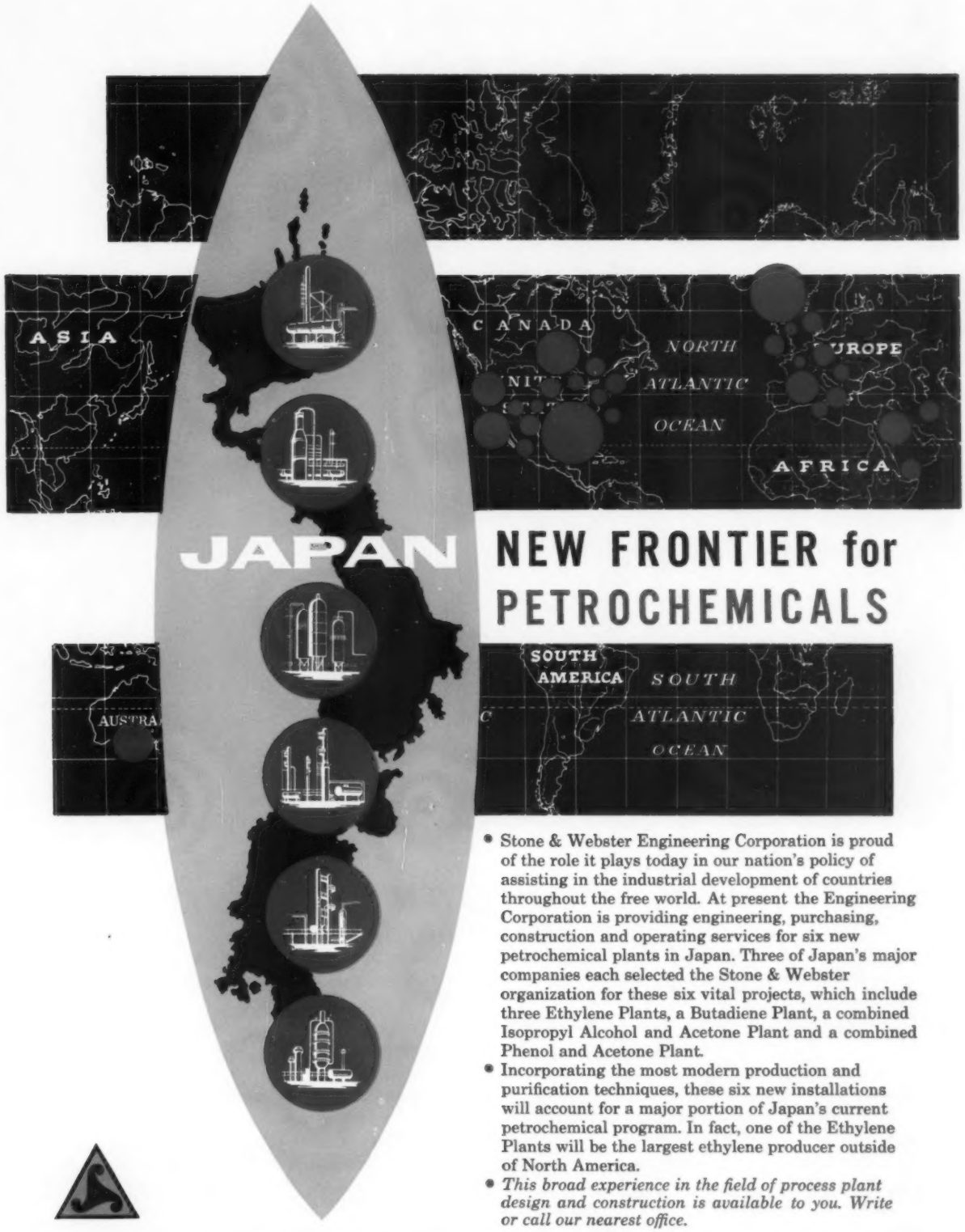
The NIAGARA Aero HEAT EXCHANGER cools liquids and gases by evaporative cooling with atmospheric air, removing the heat at the rate of input, controlling temperature precisely. You save 95% of cost of cooling water; you make great savings in pumping, piping, power; quickly recover your installation cost.

You can cool and hold accurately the temperature of all fluids, air and gases, water, oils, solutions, chemical intermediates, coolants for mechanical, electrical and thermal processes. You obtain closed system cooling free from dirt. You solve all the problems of water availability, quality or temperature.

In CHEMICAL PROCESSES this is successfully used in cooling liquids and gases, chemical reactions, condensing distillations and reflux cooling.

Write for complete information; ask for Bulletins 120 and 124. Address Dept. P.R.-5.

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N.Y.
District Engineers in Principal Cities of U. S. and Canada



NEW FRONTIER for PETROCHEMICALS

- Stone & Webster Engineering Corporation is proud of the role it plays today in our nation's policy of assisting in the industrial development of countries throughout the free world. At present the Engineering Corporation is providing engineering, purchasing, construction and operating services for six new petrochemical plants in Japan. Three of Japan's major companies each selected the Stone & Webster organization for these six vital projects, which include three Ethylene Plants, a Butadiene Plant, a combined Isopropyl Alcohol and Acetone Plant and a combined Phenol and Acetone Plant.
- Incorporating the most modern production and purification techniques, these six new installations will account for a major portion of Japan's current petrochemical program. In fact, one of the Ethylene Plants will be the largest ethylene producer outside of North America.
- *This broad experience in the field of process plant design and construction is available to you. Write or call our nearest office.*

STONE & WEBSTER ENGINEERING CORPORATION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York • Boston • Chicago • Pittsburgh • Houston • San Francisco • Los Angeles • Seattle • Toronto

Early American Oil Man

The American Indian is credited with many firsts, to which should be added the discovery of oil in America.

True, it was Colonel Edwin Drake, who, in 1859, brought in the first oil well. But long before, the American Indian had learned to skim oil off certain streams that flowed through Pennsylvania.

To the Indians, oil was medicine . . . and although their precise medicinal use may not always have been appropriate, their idea was sound . . . for today oil is actually an ingredient in many drugs.

But far overshadowing its use for drugs and by-products is the use of petroleum to power a growing America . . . petroleum in the form of natural gas . . . petroleum in the form of advanced motor oils, greases, and gasolenes.

Here, above all else, Cities Service is proud to take its place as a leader . . . the only oil company that now offers totally new grades of gasolene for every type of car.

Literally fuels of the future, these new gasolenes are the crowning achievement of the finest men, methods, and multimillion dollar refining equipment. More importantly, they are part of a continuing series of petroleum "firsts" now offered and yet to come from Cities Service . . . for as America grows, so grows Cities Service, for nearly half a century, a leader in oil progress.

CITIES SERVICE

Men in the Industry . . .

Chemical Co. prior to its consolidation into Hooker in November 29.

Dr. Stiegman is a graduate of the University of Illinois, where he received the B.S. degree in 1932, and M.S. in 1934, and a Ph.D. in chemistry in 1937. From 1933 to 1937 he held a teaching fellowship at the university.

Harold J. Rose has been appointed assistant general manager of the Esso Standard Oil Co.'s Chemical Products department. Rose has been coordinator of chemicals research for the Esso Research and Engineering Co. of Linden, N. J., since August of last year.

Rose

He received his B.S. and M.S. degrees in chemistry from the University of Kentucky and was a member of the faculty of the university from 1940 to 1942. He joined Esso Standard at the Company's Baton Rouge refinery as a research chemist, and from 1948 until 1954, served as section head in charge of petrochemicals research.

He moved to the Esso Research and Engineering at Linden in 1954, and was serving as an assistant director of the Chemicals Research division when he was named to his most recent post.

Dr. Gerhard Herzog has been appointed assistant general manager of The Texas Co.'s research and technical department.

Also **B. D. Lee** was made manager-exploration research, and **K. C. ten Brink** manager-production research.

Concurrent with these appointments, Exploration and Production Research has been established as a division in the company's Research and Technical department.

Robert H. Caughey has been named chief metallurgist by M. W. Kellogg Co. in New York, succeeding **Harry S. Blumberg**, retired to enter metallurgical consulting. Caughey has specialized in evaluation, production, and fabrication of high temperature steels for more than 20 years. He joined Kellogg in 1946 as assistant chief metallurgist. A member of several engineer and metallurgical societies, Caughey is chairman of Project Committee SP 5, a joint ASTM-ASME group studying austenitic steels for steam piping service.

Robert D. Taylor, Toronto accountant has been named controller of Refinery Engineering, Ltd. A resident of Toronto 9 years, Taylor was employed 5 years by the Standard Chemical division of the Dominion Tar and Chemical Co., Ltd., prior to becoming associated with the accounting section of the Dalex Company, Ltd., 4 years ago.

Flemming, who also serves as vice president in charge of sales for The Refinery Engineering Co., said Taylor's appointment completed another phase of an extensive expansion program instituted last

THE *Quality* LINE IN STAINLESS

CAMCO

STAINLESS STEEL PIPE FITTINGS

Camco specializes in the manufacture of stainless steel pipe fittings and this specialization has resulted in a quality product at no premium in price.

- SCREWED
- FLANGED
- WELDING

One source for all your Stainless Steel Fitting Requirements

FILL IN AND MAIL TODAY — FREE!

CAMCO Products, Inc., 445 State Street
North Haven, Conn.

Gentlemen: Please Send —

- ☐ Catalog covering complete line
- ☐ Flange Dimensional Slide Rule
- ☐ Furnish address of area distributor

Name _____

Company _____

Address _____

City _____ State _____

PR

CAMCO PRODUCTS, INC.

445 STATE STREET
NORTH HAVEN, CONN.

For more data on advertised products, use Readers' Service Cards, last page.

DROP FORGED
for Strength

HOT FORMED
for Weldability

Hot formed steel is not subject to weld cracking, a chronic complaint on cold rolled products.

HEAT TREATED
All Thredolet fittings are heat treated after forging in accordance with A.S.T.M. A105.

ANTI-CORROSIVE LACQUER COATING
All Bonney fittings stay new and ready-to-use years after leaving our factory. Threads do not get clogged with grit as do oil-preserved fittings.

BONNEY

WELDOLETS ®
THREDOLETS ®
SOCKOLETS ®
BRAZOLETS ®
ELBOLETS ®

CARBON STEEL
STAINLESS
ALLOY
for all services

consider these features then specify and use BONNEY Thredolets and Sockolets for all small branch connections . . . and Weldolets for all large branch connections.

PENNSYLVANIA DIVISION
BONNEY FORGE & TOOL WORKS
DEPT. M
ALLENTOWN, PENNSYLVANIA

Men in the Industry . . .

December by Refinery Engineering, Ltd. He said the company's accelerated operations were required to meet the increased needs of the rapidly-growing petroleum refining and processing industry in Canada.

Dr. John E. Powers, University of Oklahoma has received a $4000 grant from Socony Mobil Oil Co., Paulsboro, N. J.,

Dr. Powers, an assistant professor of chemical engineering, received the award in support of his basic research in the field of thermal diffusion. He has conducted original research in this field during the past year under a similar grant from Socony Mobil, with encouraging results.

Dr. John G. McNab has been appointed coordinator of petroleum products and medical research at Esso Research and Engineering Co. In his new position, Dr. McNab is responsible for the management of the company's research aimed at developing new or improved oil products such as engine fuels, lubricants, industrial oils, greases, waxes and chemical additives.

Dr. McNab, 43, was named director of the Products Research Division at the Esso Research Center, Linden, N. J., last July. The following month he was promoted to deputy coordinator of products and medical research, the post he held until the present appointment as coordinator.

He joined the company in 1936 after receiving his Ph.D. degree in organic chemistry from the University of Chicago. He received B.S. and M.S. degrees in chemistry at Queen's University, Kingston, Ontario.

Charles C. Swoope has been named manager of Esso Standard Oil Co.'s Baltimore refinery. Swoope formerly was general superintendent of Esso's Refinery at Bayonne, N. J.

Swoope

At the same time, the Manufacturing department announced that **Stanley A. Wuchter,** manager of southern East Coast refineries for Esso since 1948, became consultant at the Baltimore refinery. He plans to retire in September of this year. The southern East Coast office, which formerly also managed Esso's refinery at Charleston, S. C., will be discontinued.

C. A. Brown, Charleston's general superintendent, became manager of that plant under the assignment changes.

Swoope is a graduate of the University of Florida where he received an M.S. degree in chemical engineering. He started with Esso at the Baton Rouge refinery in 1928.

Later he did extensive work in chemical products at Esso's Bayway plant, becoming Paratone supervisor in 1944. The next year he moved up to supervisor of manufacturing operations in chemical products.

In 1953 he became head of Bayway's technical department and later served as Petroleum process supervisor. In 1954 he was appointed to head Esso's East Coast

For more data on advertised products, use Readers' Service Cards, last page.

We Think You'll Agree . . .

. . . that these reference works deserve a place in your technical library.

Each contains the ideas, methods, developments and descriptions you can profit from. Each provides detailed information on the subject covered. For a small cost, you'll have on hand the knowledge—the know-how—derived from years of experience by men who are recognized authorities in their fields.

THE CHEMISTRY OF PETROCHEMICAL REACTIONS

By Lewis F. Hatch

This completely indexed volume is a thorough and exhaustive treatise on basic chemistry of reactions and processing of products and intermediates classified as petrochemicals. A completely contemporary study, this book is an immediate and valuable reference for anyone engaged in the chemical or refining industry. In addition to technical data, valuable commentaries on end use and market of many significant chemicals are presented in such manner as to make this book a practical working manual.

1955, 192 pages.....Price $4.50

SPOT TESTS

By Fritz Feigl

The Fourth completely revised and enlarged English edition of Dr. Feigl's classic text and reference work "Qualitative Analysis by Spot Tests."

Vol. 1, 1954, Inorganic Applications, 530 pages. Price $7.25

INSTRUMENTS FOR MEASUREMENT AND CONTROL

By Werner G. Holzboch

Book describes, illustrates and compares all most recent devices for measuring and controlling temperature, moisture, pressure, flow, uniformity, etc. In non-mathematical language, it discusses design, construction and operation of instruments, shows how various instruments compare with each other and points out factors to consider in choosing proper instrument for a particular job.

1955, 416 pages.....Price $10.00

LIQUID EXTRACTION

By Robert E. Treybal

Complete review and organization of the subject matter of the unit operation of liquid-liquid extraction. It covers all phases of the subject, including the physical chemistry of liquid-liquid equilibria, production of equilibria, thermodynamics, of non-ideal solutions, choice of solvent, diffusion in liquids, theoretical discussion of mass-transfer, and more.

1951, 422 pages.....Price $8.50

FLUIDIZATION

By Donald F. Othmer

Contains complete and revised papers presented at the symposium on fluidization held at Polytechnic Institute of Brooklyn with the cooperation of the American Institute of Chemical Engineers. Book describes latest advances in both theory and practical applications involved in use of finely divided solids as catalyst supports.

1956, 240 pages.....Price $7.00

PETROLEUM REFINING WITH CHEMICALS

By V. Kalichevsky and K. Kobe

A comprehensive up-to-date treatise explaining various problems encountered in refining and finishing petroleum products. Detailed explanations are given on refining of petroleum with chemicals and solvents, use of additives for improving quality of petroleum products, modern testing methods and their interpretations, concept of color (as applied to color of petroleum oils), and more.

1956, 700 pages.....Price $16.50

Send for your FREE Copy of our

PETROLEUM BOOKS CATALOG

Which describes nature and contents of these and many other books pertaining to the Petroleum Industry.

POLYETHYLENE

By J. B. Allison

First organized account of all types of polyethylene. As far as possible in such a rapidly moving field, the book integrates structural observations, manufacturing conditions, properties and suitable fields of application.

1956, 564 pages.....Price $16.00

WATER TREATMENT FOR INDUSTRIAL AND OTHER USES

By Eskell Nordell

A practical coverage of water—its impurities and methods of treatment to make it fit for a great variety of industrial and other uses. Includes: chemical reactions; impurities and how they can be eliminated or reduced; water requirements for industrial uses; current water-treatment practices in various industries; problems and practices relating to boiler feed waters and cooling waters, etc.

1951, 525 pages.....Price $12.00

PATENT LAW IN THE RESEARCH LABORATORY

By John Kenneth Wise

Gives the industrial research worker a practical insight into the operations of the patent system, and shows clearly the importance of patent law in research activities. Beginning with a brief history of the patent system, book shows how patent rights are acquired, preserved and how they are sometimes lost through neglect or improper action.

1955, 155 pages.....Price $2.95

When ordering please make certain that your complete mailing address is included. Also, please designate desired books by title and author. Then send the order with your check or money order. Shipment will be made promptly via pre-paid parcel post.

Order From:

Book Department

THE GULF PUBLISHING COMPANY

P. O. Box 2608

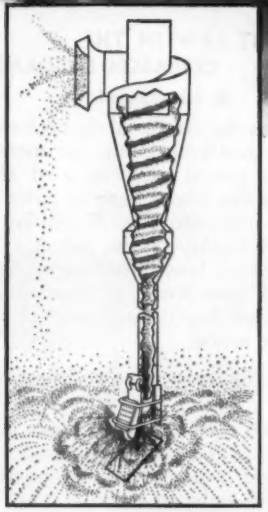
Houston 1, Texas

Positive Dip-Leg Seal

with Catalyst Density

Increased 50% or More...

DUCON TRICKLE VALVES



PATENTS PENDING

Ducon Trickle Valves provide greater stability of cyclone operation by minimizing start-up and upset catalyst losses. Increased dip-leg seal catalyst density permits greater thru-put without additional dip-leg length and vessel height. With hundreds of Ducon Trickle Valves in service, the petroleum refinery industry itself has proved their unsurpassed dependability for continuous, trouble-free operation.

Write for details now on Ducon Type CA Trickle Valves—**the first dip-leg seals with approval for fluid catalytic cracking plants.**

Ask for Descriptive Bulletin No. CV-2506

DUCON

the name in DUst CONtrol

THE Ducon COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

Men in the Industry . . .

Technical Service division, the post he held when he was assigned to the Bayonne plant as assistant superintendent last August. He became general superintendent at Bayonne earlier this year.

W. B. Schnick has replaced **J. D. Hurst** who retired this year as manager of Traffic and Shipping for Magnolia Petroleum Co.'s refinery in Beaumont, Texas. Schnick was assistant manager prior to this promotion.

R. P. Medlin has been selected for a chief process engineer post in the Technical department. He replaces **B. J. Schulz** in that capacity. Schulz has become coordinator of lubricants and allied products on the headquarters staff of Socony Mobil Oil Co., Inc., laboratories in New York. **E. J. Reeves,** assistant chief process engineer in Technical department's plant testing section, has been shifted to Medlin's previous job of planning and coordinating assistant chief process engineer. **R. A. Bowden,** formerly an assistant chief process engineer in the plant's Process Control laboratory has replaced Reeves.

W. D. Douglas has been named storehouse foreman, Beaumont refinery, replacing **E. A. Young,** who retired earlier this year. **H. C. Stokes** has replaced Douglas as assistant storehouse foreman. **Herman F. Carr** has moved up to the position of storehouse supervisor.

Dr. Vladimir L. Shipp retired as assistant to director, Technical Service department, Socony Mobil Oil Co., New York, after 26 years with the company. He was honored at a testimonial dinner attended by 200 friends and fellow employees. Dr. Shipp has started as an independent Petroleum and Asphalt Consultant with office in New York City. He has also joined the faculty of the Brooklyn Polytechnic Institute as adjunct professor of chemical engineering.

Graham F. Towers has accepted the invitation of the chairman of The British Petroleum Co. to become chairman of the board of BP (Canada) Ltd., the Canadian member of the international BP Group. Towers, who was until 1954 Governor of the Bank of Canada, is a member of the Canadian committee of the Hudson's Bay Co.

Born in Montreal and educated at McGill University, Towers has had a distinguished public career. From 1934 until 1954, he served as Governor of the Bank of Canada during a period of economic expansion. During this time, he also served as chairman of the National War Finance Committee; president of the Industrial Development Bank; and Alternate Governor, International Monetary Fund.

Dr. Carroll Karkalits has been named supervisor of research for the Petro-Tex Chemical Corp. of Houston.

Dr. Karkalits graduated from the Rice Institute in 1938 with a B.S. degree in chemical engineering and received his M.S. and Ph.D. degrees at the University of Michigan. During World War II he taught Army and Navy specialized training units and later was instructor in chemical engineering at the University of Michigan.

Then for eight years Dr. Karkalits was

Plibrico Refractories

THE *"pro"* OF *proper* PRODUCTS

There's nothing amateurish about the way Plibrico refractories get the job done. That's because there are no cure-all refractories in the Plibrico line, but rather specific types and grades tailored to lining process equipment.

Here, in brief, are a few for your work.

Plicast Verilite—a light weight insulating castable of unusual characteristics, combining low "K" factor and utmost strength. Made for pneumatic application.

Plicast Petromix (Tuff-Mix G)—a first quality dense castable specifically designed for early strength in the intermediate temperature range (1000-1500 deg. F.), and for pneumatic application.

Plicast 40—one of seven abrasion resistant castables. Designed for low iron service requirements in extreme conditions. For trowel or pneumatic application.

Ask your Plibrico man for complete details. Write, too, for our catalog covering your applications.

Plibrico REFRACTORIES ENGINEERING CONSTRUCTION

PLIBRICO COMPANY • CHICAGO 14, ILL.
Plibrico Sales & Service in Principal Cities

So SIMPLE We Can Adapt It to ANY LIQUID LEVEL CONTROL JOB

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

WHY NOT MAIL THE COUPON — NOW

MAGNETROL, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois 7
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.

USG®

SUPERGAUGE®... assures accurate, dependable process indication

USG's exclusive Arc-Loc® Movement is one reason why USG Supergauges provide many years of sustained accuracy and dependability.

The sector of the movement is stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions. Movement is also available in all stainless steel if desired.

Mono-Unit Construction permits easy removal of complete gauge movement assembly for inspection and adjustment. Accurate calibration easily made from the rear. No need to remove dial or pointer.

Supergauges are available in 4½", 6" and 8½" sizes for pressures to 20,000 psi. Call your local USG Distributor today . . . see the "Yellow Pages" of your phone book . . . or write for complete information on gauge styles and construction.

USG UNITED STATES GAUGE
Division of American Machine and Metals, Inc.
Sellersville, Pa.
Home of the SUPERGAUGE

MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

Men in the Industry . . .

group leader in the Process Development department of American Cyanamid Co. at Bound Brook, N. J. Just prior to joining Petro-Tex, he was supervisor of Economic and Process Appraisal in the Central Research laboratories of Food Machinery and Chemical Corp. at Princeton, N. J.

A. J. Broggini, 44, has been named president of the Badger Manufacturing Co., Cambridge, Mass. He succeeds **George C. Hargrove** who is retiring from active service. Hargrove will, however, remain available for consultation.

Broggini

In addition to his new duties, Broggini will continue as chairman of the executive committee. He is also a member of the company's board of directors.

In accepting his new post, Broggini expressed his confidence that the pattern of vigorous growth set by the oil refining and chemical industries would continue into the foreseeable future.

Broggini received his B.S. degree in chemical engineering from the University of Michigan in 1934 and is a member of the American Institute of Chemical Engineers, the American Petroleum Institute and Tau Beta Pi.

Charles S. Parker has been elected a vice-president of Union Oil Co. of California. Parker is director of economics and planning, with headquarters in Los Angeles. A native of California, he received degrees in chemistry and chemical engineering from the University of Southern California. He joined Union Oil in 1932 as a laboratory technician.

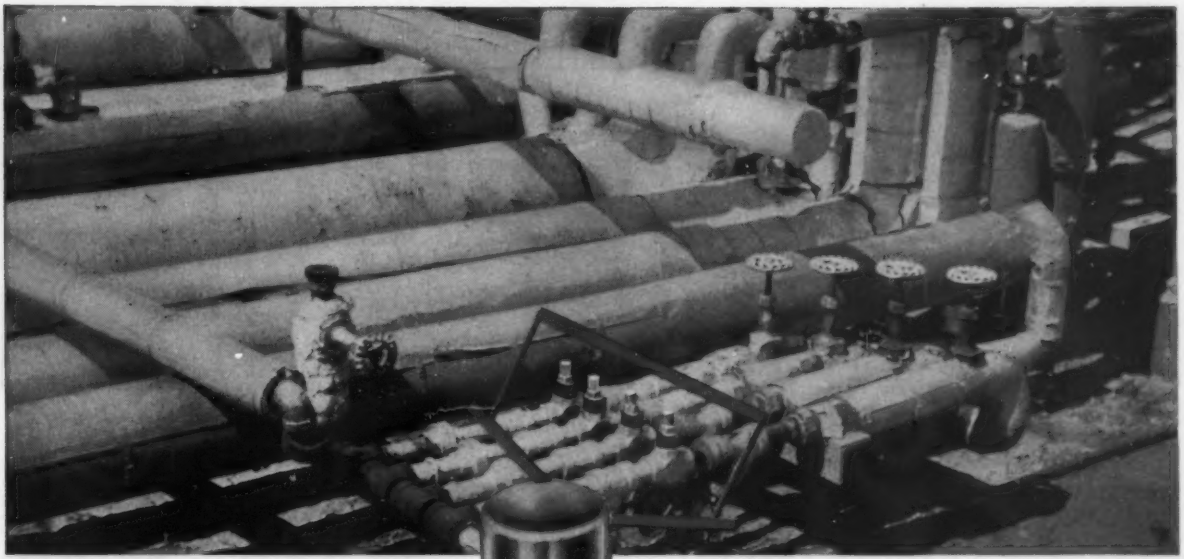
Dr. George F. Kirby, Jr. has been elected a director of Ethyl Corp. Dr. Kirby, who is vice president in charge of research and development for the company, has been associated with Ethyl since 1940. He holds a B.A. degree from Louisiana College and M.S. and Ph.D. degrees in chemistry from Louisiana State University.

John T. Snyder, Jr., has been elected financial vice president of Pan American Petroleum Corp. He will also serve on the Pan American board of directors.

Snyder attended The Hotchkiss school, Lakeville, Conn., and at Williams College, Williamston, Mass., from which he received a B.A. degree in mathematics in 1940.

The new Pan American executive has been financial vice president, secretary and director of the Southern Production Co., Inc., Fort Worth, for the past five years. Prior to then, he was a partner in the New York firm of Ingalls and Snyder, investment brokers.

Dr. Bernard M. Sturgis, director of the Du Pont Co.'s petroleum laboratory, Deepwater Point, N. J., has been appointed to the National Advisory Committee for Aeronautics subcommittee for aircraft fuels.



Yarway Impulse Steam Traps on refinery tracer lines, discharging into a common header.

the *right* Steam Trap for Tracer Line Service

The Yarway ½" No. 20-A Impulse Steam Trap is known throughout the processing industries as the right trap for steam tracer lines. The No. 20-A is especially designed for efficient handling of tracers, steam main drips, and other *light condensate loads.*

Small size, light weight, stainless steel construction, only one moving part, maintenance of high even temperatures, and resistance to freeze-ups are distinctive Yarway Impulse Trap features. Well over a million Yarways proved by performance.

Yarways are available through 270 convenient Industrial Distributors. Write for name of one nearest you.

YARNALL-WARING COMPANY 128 Mermaid Avenue, Philadelphia 18, Penna.

● FREE BULLETIN ON STEAM TRACING

If you'd like to have a new, helpful 8-page bulletin dealing exclusively with trapping steam tracer lines, write for "How to Steam Trace". It's free!

YARWAY

impulse® steam trap

The Impulse that revolutionized steam trapping 20 years ago.

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Proudfit

Charles W. Proudfit has been appointed director of sales of the newly created Resin Products department of Celanese Corp., of America's Plastics division. He will supervise sales of Celanese polyester resins and polyvinyl acetate emulsions used in the paint, textile, paper and other industries.

Proudfit joined Celanese from a position of sales manager of the Hormann-Seitz Manufacturing Corp., Newark, N. J., and has an extensive background in the sales of vinyl emulsions, polyester resins and drying oil products.

Prior to his last position, Proudfit had a number of years experience as a sales representative for polyester resins and vinyl emulsions for the Naugatuck Chemical division of U. S. Rubber.

Johnson

J. H. (Jerry) Johnson has been appointed sales engineer for Tod Pazdral Pipeline Specialties, Houston. Johnson, with many years of experience in oil and gas construction engineering, will serve the Louisiana, Mississippi and East Texas area.

Carroll

W. A. (Bill) Carroll, Jr., has been named general sales manager of the Industrial Silencer division of Burgess-Manning Co. Mr. Carroll has served as New York District Manager of the Company for several years and takes up his new duties with a broad experience in the field of silencing exhaust and intake noise from engines, compressors, blowers and pressure reduction systems, and pulsation elimination in gas pipings. His new office is essentially a part of the expansion program of Burgess-Manning Co., and he will headquarter in the Dallas office, assuming the sales responsibilities which were previously under the direction of Mr. Paddock.

Luetzow

Howard J. Luetzow has been appointed technical sales representative in Chicago and surrounding areas, announced Wolverine Tube, Division of Calumet & Hecla, Inc.

Formerly technical office sales representative of Wolverine's general sales office, Detroit, Luetzow will contact petroleum, petrochemical and chemical companies plus heat exchanger manufacturers and fabricators. He will headquarter in Wolverine's Evanston Office.

Morgan

Patrick N. Morgan has been named assistant to the vice president and general sales manager of the Heater & Tank division of John Wood Co. Morgan's duties will be concerned with organizational and administrative matters in conjunction with the division's sales force.

Morgan was formerly manager of sales for heating and air conditioning products with Combustion Engineering, Inc. Prior to joining Combustion Engineering eight years ago, he held executive posts with the Tennessee Valley Authority and the Georgia Power Co. A graduate of the University of Alabama in electrical engineering, he served as an officer in the Seabees during World War II.

William Ohly has been appointed manager of distributor sales for Acro division of Robertshaw-Fulton Controls Co. Ohly will supervise sales to distributors of the standard line of precision switches manufactured by Acro. The division, which also produces a complete line of temperature controls for heating equipment, was recently acquired by Robertshaw-Fulton.

Ohly formerly served as sales engineer with Acro Manufacturing Co. He graduated from Miami University in 1936. From 1951 to 1955, he was supervisor of procurement for Johns Hopkins University. During World War II, he served as a lieutenant commander in the U. S. Navy.

Ohly

Boyd

Raymond Boyd, Jr., has been promoted to manager of the Industrial divisions and Foreign Operations of U. S. Hoffman Machinery Corp.

Boyd has been connected with U. S. Hoffman since 1946. Until his recent elevation, he was manager of the Air Appliance department of the Industrial divisions. A graduate of Brown University, Boyd is a resident of Westport, Conn.

Aucoin

Edward S. Aucoin has been promoted to purchasing agent for Delta Tank Manufacturing Co., Inc. Aucoin has served as buyer, expeditor and assistant purchasing agent since joining Delta two years ago. Prior to that he was an inspector for the Federal Public Housing Authority and purchasing agent for the Department of the Army's Baton Rouge Engineer Depot.

A native of Plaquemine, La., Aucoin is a lieutenant colonel in the Army Reserve Corps.

Clark

Willard D. Clark has been appointed district sales representative in the New England area for The Pfaudler Co., Rochester, N. Y.

A graduate chemical engineer from Northeastern University, Clark has more than 15 years experience in sales and sales engineering. Prior to joining The Pfaudler Co. in November 1956, he was associated with Colgate-Palmolive Co. and MacAlaster Bicknell Co. Clark will conduct activities from Pfaudled's Boston area office.

Sheingold

Daniel H. Sheingold has been appointed director of applications engineering of the George A. Philbrick Researches, Inc. Sheingold, recently returned from the Army, participated in research, design, development and application of electronic analog computing circuits and techniques during his previous association with Philbrick from 1949 to 1955. He developed a new principle of analog division by means of feedback without the use of high loop gain. Mr. Sheingold presented a paper on "Theory and Application of High Speed Electronic Models" at the 1954 A.I.E.E. Convention.

Sheingold received a B.S. degree in electrical engineering from Worcester Poly-

AGAIN—Blaw-Knox points the way

. . . this time to ASHLAND's 6,000 bpd source of high octane gasoline

The catalytic reforming and hydrogen desulfurization unit, now in operation, is the latest of eight Blaw-Knox units which are operating successfully in the petroleum industry—to supply high octane gasoline for today's high compression motors. Engineered, constructed and installed by Blaw-Knox, it provides a capacity of 6,000 bpd in the Buffalo Refinery of the Frontier Oil Refining Division of Ashland Oil and Refining Company.

The wide experience of Blaw-Knox engineers in catalytic reforming, as well as other petroleum and chemical processes, is always available to you. We welcome the opportunity to discuss your proposed modernization, expansion or new plant projects with you—and to offer our recommendations.

BLAW-KNOX

BLAW-KNOX COMPANY

Chemical Plants Division • Pittsburgh 22, Pa. • Chicago 1, Ill.

Birmingham • New York • Philadelphia • San Francisco • Washington, D.C.

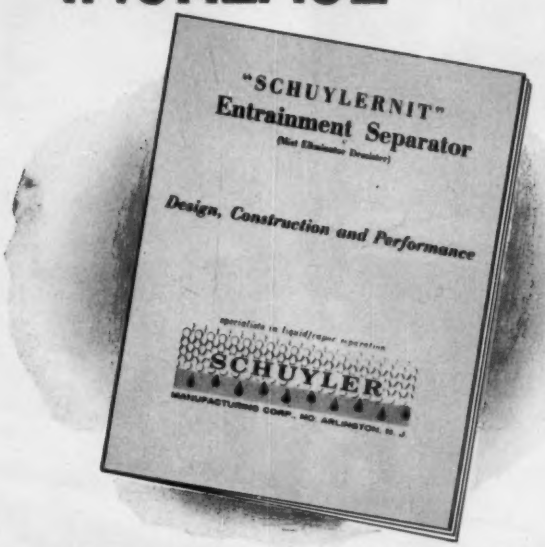
Designers, engineers and builders of plants for the process industries; chemicals • petroleum • petrochemicals • resins and plastics • nuclear energy • fats and oils • fertilizers • synthetic fuels

For more data on advertised products, use Readers' Service Cards, last page.

TO STOP COSTLY LIQUID LOSS

... IMPROVE PRODUCT QUALITY

... INCREASE THRUPUT CAPACITY



SEND FOR THIS ***FREE*** ENTRAINMENT MANUAL TODAY!

This new, completely illustrated, 16 page "Schuylernit" Entrainment Manual shows how to get clean, positive liquid/vapor separation in vacuum and flash towers, absorbers, scrubbers, evaporators and distillation equipment.

REPRESENTATIVES: RAWSON & CO., 1223 Waugh Drive, Houston 19, Texas
BUSHNELL CONTROLS & EQPT. CO., 5137 W. Jefferson Blvd., Los Angeles 16, Calif.
THE CONDIT COMPANY, 1011 South Main St., Tulsa 19, Okla.

Copyright 1957 Schuyler Manufacturing Corp.

SCHUYLER MANUFACTURING CORP.
80 Porete Avenue, North Arlington, New Jersey
Gentlemen:
Please send me without obligation a copy of your "Schuylernit" Entrainment Manual.

Name_____ Title_____

Firm_____

Address_____

City_____ State_____

specialists in liquid/vapor separation

SCHUYLER

MANUFACTURING CORP., NO. ARLINGTON, N. J.

Suppliers . . .

technic Institute in 1948 and an M.S. degree from Columbia University in 1949.

HORIZONS, INC., has appointed **Dr. Charles J. Strickler** section head of organic chemistry in the Chemistry department. A graduate of Purdue University, Dr. Strickler received his Ph.D. degree from the University of Illinois. He obtained his industrial experience at the Abbott Laboratories of Chicago, The Michigan Chemical Corp. of St. Louis and Diamond Alkali Corp. of Cleveland.

With these organizations, Dr. Strickler worked in various capacities, including that of a research and development chemist, supervisor of research activities and as an exploratory research chemist.

THE MILTON ROY CO., Philadelphia, has appointed **Selig Schrager** to its market development staff

A graduate of Temple University in 1952, he holds a Bachelor of Science degree in Journalism. There he was a staff writer on the **Temple University News** and radio station WRTI. Formerly employed as sales promotion-engineer by Brown Instrument division of Minneapolis-Honeywell Regulator Co., his present duties with Milton Roy include the preparation of technical and sales promotional literature, advertising, publicity and other market development activities.

DAVIDSON-KENNEDY ASSOCIATES CO. has appointed **James E. Iliff** vice president-general manager. In his new assignment, Iliff will direct the Chicago office of the engineer-contractor firm.

Iliff, a chemical engineering graduate of Iowa State College, was formerly chief process engineer of the Blaw-Knox Co., Chemical Plants division, Midwest headquarters. At Blaw-Knox he organized the chemical process engineering department and pioneered that company's entrance into the design and construction of fertilizer plants. Since 1942, Iliff has been active in research, development, design, construction and operation of many chemical process plants. He joined Davidson-Kennedy Associates in January.

METAL GOODS CORP. Vice President **Howard S. Reasor,** was elected president of the National Association of Aluminum Distributors at their sixth annual meeting. During the past four years he has been active in this association, which is composed of companies engaged in the distribution of aluminum and other metal products. Before assuming the office of president, Reasor served as chairman of the statistics committee of this group.

Reasor is a graduate of Purdue University. He received a BS degree in chemical engineering there in 1922. In 1937, he joined Metal Goods Corp. and was elected to vice president in 1941.

CAMERON IRON WORKS, INC., has promoted **W. L. Reynolds** from manager of the Mid-Continent district at Tulsa to a staff assistant to the sales manager in Houston.

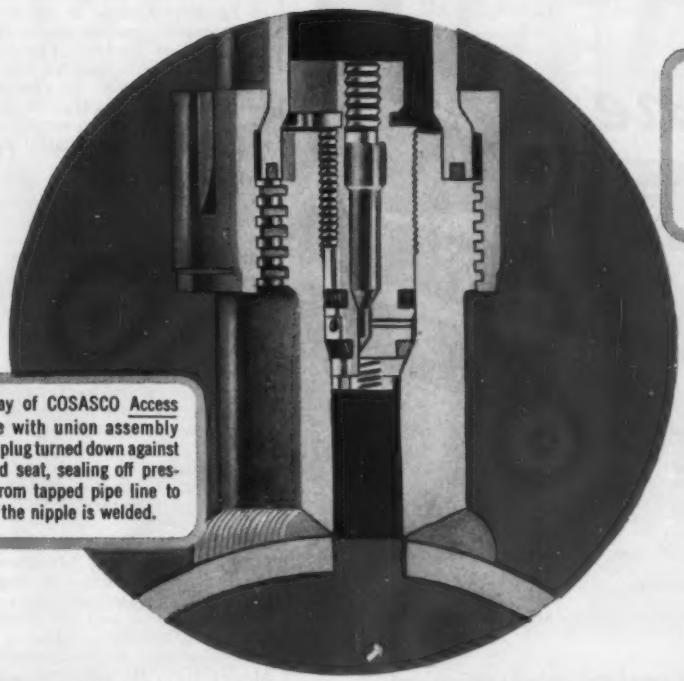
Radean Hallmark was named district manager replacing Reynolds, while the Mid-Continent district headquarters was moved to Chickasha, Okla. At the same

For more data on advertised products, use Readers' Service Cards, last page.

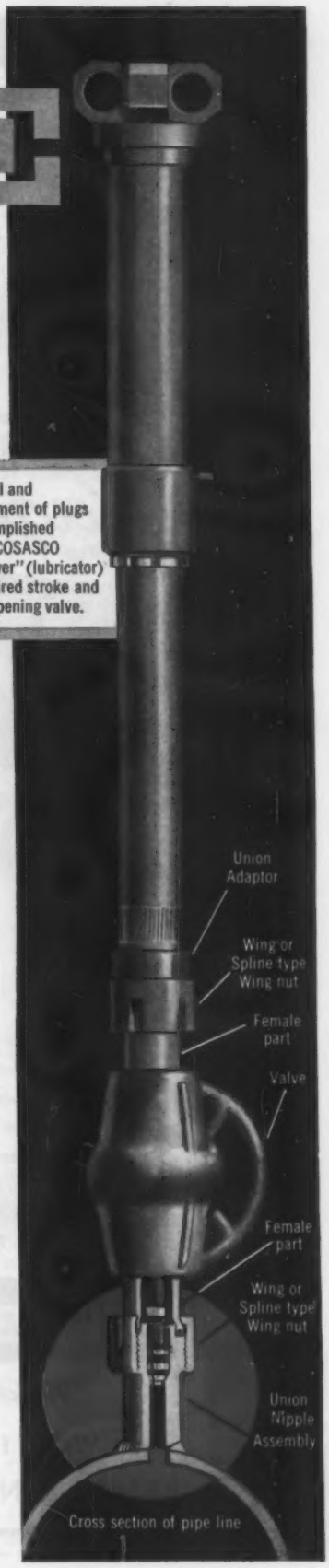
SAFE

entry against pressure

...to insert instruments, replace valves, investigate corrosion!



Cutaway of COSASCO Access Nipple with union assembly shows plug turned down against tapered seat, sealing off pressure from tapped pipe line to which the nipple is welded.



Removal and replacement of plugs is accomplished with a COSASCO "Retriever" (lubricator) of required stroke and a full-opening valve.

COSASCO *Access* Nipples give you safe and easy entry into well heads, refinery vessels, storage and transmission equipment *without interfering with operations.* They also replace expensive valves and permit removal of other externals *without loss of pressure or product!*

The COSASCO *Access* Nipple has a removable threaded plug of type 303-304 stainless steel which seals off the nipple when turned down against the tapered seat. This plug is readily replaced by special plugs for inserting corrosion coupons, water samplers, thermocouples, hydrogen probes, etc. The *Access* Nipple can also function as a gauge valve or bleeder valve.

What's your problem?

If you have an entry-against-pressure problem, we invite you to submit details. Send blue prints or drawings depicting the problem and we'll supply the COSASCO solution *without charge.* You will be under no obligation whatsoever for this service.

Protect equipment... save product

COSASCO DIVISION OF PERFECT CIRCLE CORPORATION

3463 Ocean View Boulevard, Glendale 8, California
Address Mail to P. O. Box 277, LaCanada, California
Export Office: 617 S. Olive Street, Los Angeles 14, California

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

time **Roy Uhl** was named manager of the Tulsa sales office.

Reynolds, who joined Cameron in 1948, has served as district manager since 1953. Prior to that he was with Magnolia Petroleum Co. for 22 years in Oklahoma.

ASKANIA REGULATOR CO. has announced the appointment of **G. L. Stancliff, Jr.**, as vice president and general manager. Askania Regulator Co., Chicago, is a subsidiary of General Precision Equipment Corp.

UNION CARBIDE AND CARBON CORP. has announced plans for a 52-story office building of stainless steel and glass, to house its offices in New York. The building will occupy the block between Madison and Park Avenues, from 47th to 48th Streets. This site is presently occupied by the Marguery apartment-hotel.

The structure, to be known as the Union Carbide Building, will consist of a single-block tower facing Park Avenue and a 12-story section fronting on Madison Avenue. The estimated construction cost is $46 million. Towering some 750 feet above street level, the new Union Carbide headquarters will be the tallest building on Park Avenue. It will contain approximately 1.5 million square feet of space, making it one of New York's largest office buildings.

foster Lagtone

COLORED INSULATION PROTECTION

Can be cleaned with soap and water or with mineral spirits or kerosene.

Highly resistant to abrasion and outdoor weathering.

Can be applied over hard asphalt coatings and sealers without bleeding; (soft or oily asphalts may cause discoloration). Withstands fumes and occasional spillage of dilute acids, alkalies and other chemicals.

Colors other than those listed below can be made on the job by the use of Foster tinting bases or at the Foster plant on special order.

Which Color Will You Use?

Write for illustrated brochure

BENJAMIN foster COMPANY

4635 W. Girard Avenue PHILADELPHIA 31, PA.

GENERAL AMERICAN TRANSPORTATION CORP. has announced the election of **A. E. Douglass** to its board of directors.

Douglass is chairman of the board of Fuller Co., Catasauqua, Pa., a wholly-owned subsidiary of General American.

He was vice president and general manager of Fuller Co. from 1926 to 1929; president from 1929 to 1939; chairman of the executive committee from 1939 to 1954 and president from 1954 to 1957. He has been chairman of the board of Allentown Portland Cement Co., Allentown, Pa., from 1951 to date and was president of that company from 1938 to 1951.

PHILBRICK RESEARCHES, INC., Treasurer **George A. Philbrick**, Boston, Mass. was presented a special award at the April meeting of the Instruments and Regulators division of The American Society of Mechanical Engineers.

This award was granted in recognition of his contributions in the field of analog computation, and its application to industrial process control. From his concepts and the applications of the high speed electronic models he originated have stemmed major advances both in the science and in the general understanding of industrial process control dynamics.

GENERAL GAS CORP. has elected **Rawlston D. Phillips** chairman of the board of directors. Succeeding him as president and chief executive officer of the liquefied petroleum gas firm is his brother, **Hal S. Phillips**, founding member and director of the organization, board chairman of its wholly-owned subsidiary, Delta Tank Manufacturing Co., Inc., and former treasurer of General Gas.

Other elections announced by the firm were those of **Richard M. Mills** to the board of directors and **Arthur C. Rhyne** to the newly-created post of secretary-treasurer. Mills is vice president and general manager of General Gas's Eastern division in Macon, Ga. Rhyne is a director and former secretary of the company.

MATHIESON PAN-AMERICAN CHEMICAL CORP. is completing arrangements to organize its own distributing organization in Cuba for high analysis pelletized fertilizer.

Juan Aguayo will be transferred from Mathieson Quimico, Mexico, to become sales manager. His headquarters were in Mexico City. He will be assisted by **Claus Tameling** who formerly was assistant product manager for fertilizer for the Chemicals International division of Olin Mathieson Chemical Corp. in New York.

Both Mithieson Pan-American and Mathieson Quimico are subsidiaries of Olin Mathieson Chemical Corp.

As part of its Cuban operation, Mathieson is readying warehouse facilities in the port of Pastelillo, near Camaguey.

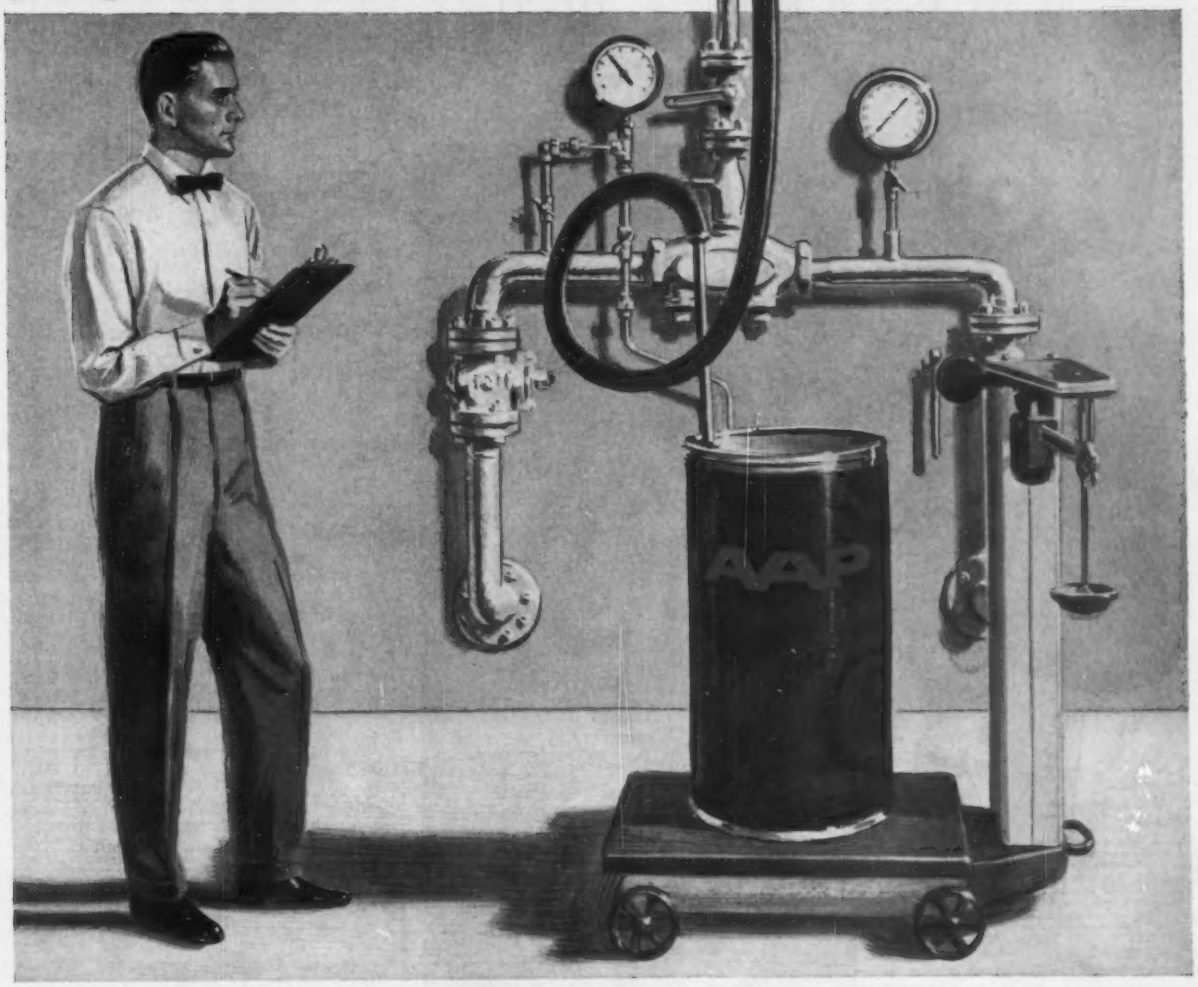
HOOKER ELECTROCHEMICAL, LTD.'S $12 million chlorine-caustic soda plant is to be completed in June 1957. The plant occupies a 110-acre site, much of which was built from tidewater land by dredging more than a million cubic yards of gravel and stone from Burrard Inlet. Parallel to the Inlet is a dock, 500 feet long, which will accommodate coastal ships to deliver salt, the basic raw material.

At right angles to the dock is a 350-foot long ferry slip to accommodate barges fitted with railway tracks. Plant tracks extend to the edge of the slip so chlorine and caustic soda tank cars can be loaded directly on barges for shipment to other ports when desired.

The first chlor-alkali plant in Western

For more data on advertised products, use Readers' Service Cards, last page.

putting COLOR to work for the petroleum industry



More and more petroleum refiners are turning to American Aniline for experienced help in utilizing oil colors to simplify identification and impart added sales appeal to motor oils, greases and gasolines. A.A.P. Oil Colors are nationally known for their constancy of shade and strength. Each may be employed in a variety of ways including the popular **eductor system.** All A.A.P. dye drumheads are equipped with a plastic opening to accommodate the dry-dye eduction tube. Colored plastic plugs representing the color of the dye in each drum are furnished with each shipment. A sales engineer from our nearest branch is ready to furnish details on the full range of shades available.

MAIL COUPON TODAY FOR FREE SAMPLE KIT

AAP

AMERICAN ANILINE PRODUCTS

A UNIT OF KOPPERS CO., INC.

KOPPERS BUILDING, PITTSBURGH 19, PA. PLANT: LOCK HAVEN, PA. BRANCHES: Providence, R. I. • Philadelphia, Pa. • Paterson, N. J. • Chicago Ill. • Charlotte, N. C. • Chattanooga, Tenn. • Columbus, Ga. • Los Angeles, Cal. Dominion Anilines & Chemicals, Ltd., Toronto, Canada • Montreal, Canada

Please send FREE your laboratory evaluation kit as illustrated of A.A.P. Oil Colors to:

NAME.....

FIRM.....

POSITION.....

ADDRESS.....

Mail to our Pittsburgh office or nearest branch. Our local representative will be happy to offer full information and technical advice at any time.

For more data on advertised products, use Readers' Service Cards, last page.

SOLVE YOUR MIXING PROBLEMS

A tremendous variety of fluid mixing needs are ably handled by the complete line of Eastern Mixers. Size and power of mixers are flexible to help solve your problems. For complete information and engineering data, write for Eastern Fluid Mixing Catalogs. Eastern engineers are always available to work out your complex mixing problems with you.

EASTERN INDUSTRIES ★ MIXER DIVISION ★

Eastern INDUSTRIES, INC.

Dept. E, Regent St., Norwalk, Conn.

Suppliers . . .

Canada, this will be the first Hooker plant to use the newest larger Hooker Type S-3B cell producing chlorine and caustic from purified brine.

The plant is designed for an initial daily capacity of 100 tons of chlorine, 110 tons of caustic soda, and a million cubic feet of hydrogen.

WOLVERINE TUBE, division of Calumet & Hecla, Inc., has named **James C. Cameron** to fill the newly created post of manager of market research.

Cameron brings to his new post an extensive and varied background in the field of market research and analysis. He was most recently with the management consultant firm of J. D. Woods and Gordon, Ltd., Toronto, Canada.

He will make his headquarters at Wolverine's General Sales offices in Detroit.

UNITED STATES STEEL CORP. has appointed **Robert M. Sherrard** area manager, production equipment sales, for the company's Oil Well Supply division at Casper.

Sherrard was employed in 1936 at Casper and worked for the division at Salem and Clay City, Ill. prior to his leave of absence to serve in the U. S. Marine Corps in 1942. He returned in 1946 at Mattoon, Ill. as store manager. Later in the same year he was transferred to Olney, Ill. as district material supervisor, becoming district merchandise manager at this location in 1951. In 1954 he was appointed district representative at Casper, the position he held prior to his present appointment.

CAMERON IRON WORKS, INC. has transferred **Scott M. Lamberth** from the sales and service office at Lake Charles, to the firm's office in Farmington, N. M.

A native of El Campo, Texas, Lamberth has been with Cameron since April, 1952. He was the recipient of the Bausch & Lomb science award upon graduation from high school in El Campo. He attended Texas A & M college before entering the Marine Corps during World War II.

BROWN & MORRISON, manufacturers' representative with offices in Charlotte, N. C., has recently been appointed sales representative for Conoflow Corp. in the states of North and South Carolina.

Brown & Morrison has been a manufacturers' representative in the instrument and controls field for a number of years. Partners in the organization are: W. C. "Bill" Morrison, Harold K. Couch, and Donald H. Jones.

Morrison studied engineering at the University of North Carolina, and has had engineering and sales experience with both manufacturers and representatives. Couch received his engineering degree from Georgia Institute of Technology, and spent more than twelve years with the Babcock & Wilcox Co. as a sales-applications engineer. Jones, also a graduate of Georgia Institute of Technology, was sales manager for the Milton Roy Co., Philadelphia, before joining the partnership in 1955.

TUBE TURNS, Louisville, Ky., has announced that **Louis Norheimer,** production control manager of the company, has been elected treasurer pro tem of the newly established American Production and Inventory Control Society.

The American Production and Inven-

SHOOT

POUR

TROWEL

ADACAST extra strength refractory

...SPECIALLY FOR PETRO-CHEM APPLICATIONS

... ADACAST Extra Strength is a castable that can be shot, poured or trowelled ... *specially designed* for those applications where high strength and resistance to abrasion and fly ash erosion are of prime importance (where high temperature resistance is not so much a factor). For Oil Stills and Heaters ... BOTFIELD Castables are manufactured in all grades ... from high strength dense to extremely light weight ... with high insulating value ... for *every* purpose in the Refining and Chemical Processing Industries.

Write for the new BOTFIELD Refractory Castables bulletin # 27

Yellow pages of 'phone book have your nearest ADAMANT Distributor.

Botfield

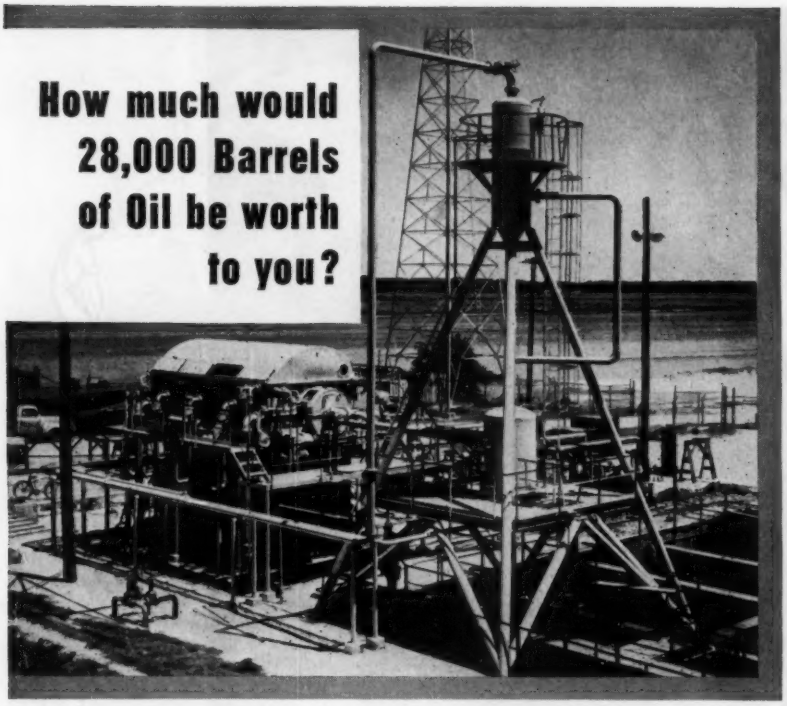
FOUNDED 1907

REFRACTORIES

ADAMANT and other ADA products

swanson and clymer sts.
philadelphia 47, penna.

For more data on advertised products, use Readers' Service Cards, last page.



That's what Cities Service Refining Co. reclaimed *in one year* with this slop oil filter station at Lake Charles, La. To be exact, it was 28,734 barrels of oil – all from slop oil and separator bottoms emulsions which previous treatment had failed to break.

In operation, 50 bags of Dicalite Speedplus are used to build a 2½"-thick precoat on the 400 sq/ft stainless steel screen of the Eimco vacuum precoat filter. The charge is usually separator bottoms (60%) and slop oil (40%). At a drum speed of ⅓ rpm, with knife cut of .003", the filter cycle is 40 hours. Flowrates range from 2 to 10 gal/ft²/hr, averaging about 4.

Similar slop oil filtration systems, using a Dicalite filter-aid, have been in use during the past few years in several refineries. Their operating data show that slop oil filtration is *not* an added cost . . . frequently these filter systems recover their entire investment in the first year. From there on, their output is largely pure profit – with the added advantage of no waste disposal problem, since the separated water contains so little oil that it may be discharged without stream pollution, or may be recycled for some process operations.

A Dicalite service engineer will be glad to discuss this problem with you, and the services of the Dicalite Laboratory are at your disposal for tests. Just write . . .

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

Dicalite Division, Great Lakes Carbon Corporation, 612 S. Flower St., Los Angeles 17, Calif.

Suppliers . . .

tory Control Society was recently organized at a meeting of industrial executives in Cleveland. Nyles Reinfeld, of the National Institute of Management, Inc., served as temporary chairman. When the constitution and bylaws are drafted a network of local chapters will be set up throughout the United States and Canada, it is announced.

Other pro tem officers of APICS are president, **M. W. Maddox** of the Mueller Brass Co., Port Huron, Mich.; vice president, **R. E. Carruth** of the Acushnet Process Co., New Bedford, Mass.; and secretary, **Don Burkhart** of the Haynes Stellite Corp., Kokomo, Ind.

DIAMOND ALKALI CO.'S chairman and chief executive officer **Raymond F. Evans** has been elected to the board of directors of Ionics, Inc.

Diamond and Ionics recently established a research partnership through which the Cambridge company will conduct research for Diamond, a leader of basic chemicals for industry and agriculture. Ionics is a producer of water demineralization equipment employing the electric membrane process pioneered by the company.

Evans joined Diamond Alkali as a production worker following his graduation in chemistry from Princeton University in 1931. He was later transferred into research. During World War II he served as president of Diamond Magnesium Co. which the parent concern operated for the government. He served as vice president and general manager of Diamond's Painesville, Ohio, plant prior to his appointment as executive vice president in 1946. He became president in 1947 and chairman in 1954.

UNITED STATES STEEL CORP. has announced the appointment of **John H. Ahrens** as district engineer, machinery and equipment sales, the company's Oil Well Supply division.

Ahrens was employed by "Oilwell" in 1953 as an engineer trainee at Casper, Wyo. In 1954 he was appointed field rep-

Be Sure To Check This Month's Classified Section in REFINER

Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

QUICK! ECONOMICAL! RESULTFUL!

Help Wanted! Classified Ads in Petroleum REFINER get the job done.

AUTOMATIC CONTROL of REFINERY PROCESSES at your fingertips with PETRECO

PETRECO ELECTROFINING

Electric treatment of distillates, pioneered by Petreco, is a continuous, precision-controlled automatic operation that's superior in every way: *easier to use,* because it affords once-through automatic treatment; cheaper, because it requires one vessel instead of 3 or 4 as in conventional systems; also, less piping, pumps and ground area are needed.

PETRECO BENDER PROCESS

Sweetens gasoline, kerosine, jet fuel and No. 2 fuel by catalytically converting the mercaptans to disulfides. The chemical cost is low and throughput rates are consistently high. The catalyst requires only occasional regeneration, and this can be conveniently done right at the plant site.

PETRECO ELECTRIC DESALTING

The electrically-shielded multiplane field, developed by Petreco engineers, removes salts, solids, and other impurities in the 98-100% range. This process is the result of 46 years of continuous development. Refiners throughout the world consider the Petreco all-electric desalters an integral part to crude oil processing.

PETRECO LUBE OIL TREATING

A continuous, automatically-controlled treating method. Replaces conventional batch agitator method of acid treating lube oil stocks. The use of an electric field causes rapid coagulation and settling of the sludge, so that mixing of acid and raw lube stock can be more intense. This results in chemical savings in both the acid and neutralization stages.

WANT MORE INFORMATION? *Write for additional literature, stating your particular interest or problem.*

PETRECO®

A DIVISION OF PETROLITE CORPORATION

3202 S. WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 EAST BURNETT STREET, LONG BEACH 7, CALIFORNIA

AR 57-1

Specialized Electric Petroleum Treating

DESALTING • DEHYDRATING • CAUSTIC WASHING • ACID TREATING • DOCTOR TREATING • SWEETENING • NAPHTHENIC ACID REMOVAL • SEDIMENT REMOVAL

For more data on advertised products, use Readers' Service Cards, last page.

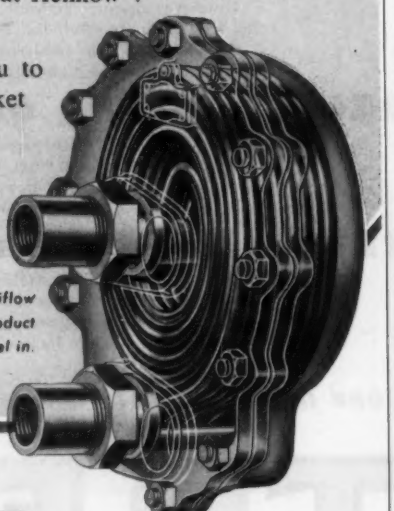
"Traveling in the Best of Circles"

Your product will be "traveling in the best of circles" when you use HELIFLOW® EXCHANGERS.

Heliflow® rates high in the blue book of heat transfer society—truly a thoroughbred—or, more appropriately, we might say a "bearcat" when it comes to doing your job. High rates of heat transfer, a cinch to clean—and just like old Uncle Remus—dependable. When it comes to pushing BTUs around you just can't beat Heliflow®.

So—let's go. Buy Heliflow®.

Seriously, though, we defy you to find any exchanger on the market today that is packed with more BTUs for your dollar than Heliflow®. Ask our local office; they can prove it.



These are the Heliflow "circles" your product will travel in.

Graham

MANUFACTURING CO., INC.

415 LEXINGTON AVE., NEW YORK 17, N. Y.

Offices in principal cities and Canada

Suppliers . . .

resentative at Casper and later in the same year was named assistant district engineer, machinery and equipment sales, at this location.

He attended the University of Louisville, where he received his B.S. degree in mechanical engineering.

HAMMOND IRON WORKS, has announced the appointment of **E. F. Trombley,** Bridgeport, Conn. as representative throughout Connecticut, and Gribbons Oil Equipment Co., South Weymouth, Mass. as representative throughout Rhode Island and Eastern Massachusetts.

CLEAVER-BROOKS CO. has appointed **The Norbert W. Enslen Co.** manufacturer's representative for the sale of Cleaver-Brooks boiler equipment. Located in Dayton, Ohio, the company represented by Norbert Enslen will provide information on the line of Cleaver-Brooks self-contained boilers for heating or processing applications and provide general engineering assistance on all applications.

GILBERT & BARKER MFG. CO., West Springfield, Mass., and Fischer & Porter Co., Hatboro, Pa., have concluded an agreement whereby the latter will become sales agent for the Gilbarco Electronic Tank Gauge. In addition, Fischer & Porter will take over the manufacture of the Gilbarco Null Balance Tank Level Receiver, which, combined with the F & P Digital Data Systems, will provide a complete tank gaging and digital readout system.

Gilbarco and Fischer & Porter will exhibit the complete gaging system for the first time at the Petroleum Industry Electrical Association—Petroleum Electric Supply Association Convention in Houston on April 16-18, 1957.

RELIANCE STEEL PRODUCTS CO., McKeesport, Pa., has opened a district office at 250 East Forty-Third Street, New York City.

John Karboska has been appointed district manager for Reliance Steel Grating, Relgrit, Bridge Flooring and Steel Mill Equipment.

J. R. SIMPSON & CO., Chicago, exclusive representative for Conoflow Corporation in northern Illinois and northwestern Indiana, has added **George H. Freundlich** and **Richard G. Klitchman** to the staff of the organization.

Freundlich is an electrical engineering graduate of the University of Purdue. He has had experience in the instrument and controls field, having spent nearly ten years as a sales engineer for both a manufacturer and a representative, before asso-

Free to PETROLEUM REFINER Subscribers

Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings. Use Readers' Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

HF

HYDROFLUORIC ACID

anhydrous and aqueous

STAUFFER HAS IT...
IN QUANTITY AND QUALITY

Available in tank cars of 22- and 42-ton capacity.

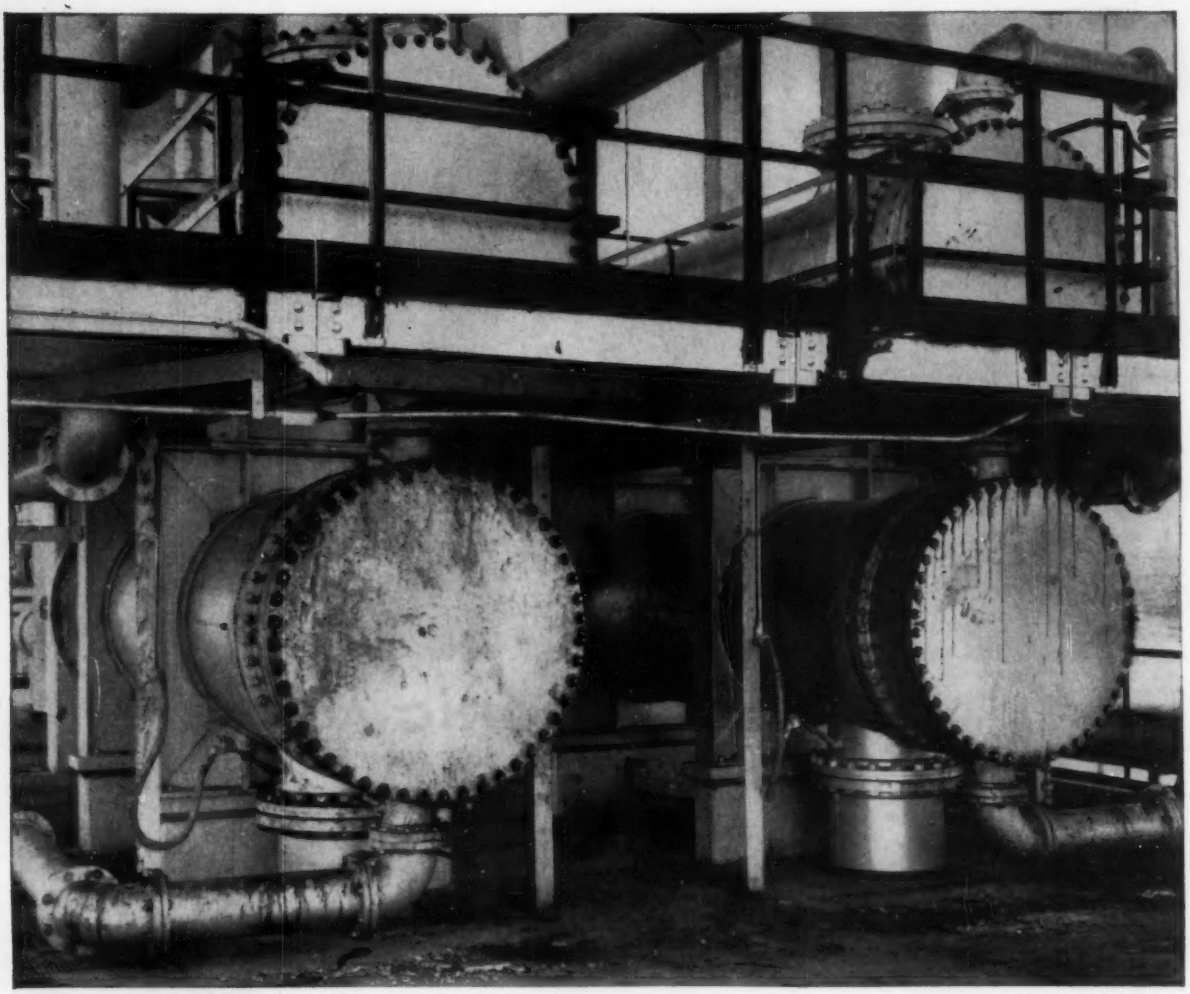
STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N.Y.

Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.

NYOTEX CHEMICAL DIVISION, P.O. Box 9716, Houston 15, Tex.

Stauffer CHEMICALS SINCE 1885



Creole finds No Measurable Corrosion of cupro-nickel tubing after 6½ years in salt water condenser

When designing a new refinery in Venezuela, the Creole Petroleum Corp. specified cupro-nickel tubing to assure long life for its salt water condensers.

After 6½ years' service at their Amuay Bay Refinery, inspection reports on 70-30 cupro-nickel tubing in overhead salt water condensers (top) showed *no* measurable corrosion, except for slight impingement caused by fouling.

Tubing in the crude-overhead partial condensers (bottom) also 70-30 cupro-nickel exhibited no corrosive attack.

Elsewhere in the plant, 90-10 cupro-nickel tubing in fuel oil cooler shows no measurable corrosion *after four years' service.*

If operating conditions cut the life of your tubes, and cut into profits as well, nickel-containing alloy tubes may be the solution to your problem. Write for 28-page illustrated brochure, "Alloys for Heat Exchange Problems." Tells you what alloys have been successful under severe operating conditions.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

ciating with J. R. Simpson & Co. During World War II, he served as an officer in the Army.

Klitchman also received his electrical engineering degree from the University of Purdue. Before joining J. R. Simpson & Co., he was employed as a project engineer for a large instrument manufacturer, and as chief controls engineer for a consulting engineering firm. He served as an officer in the Air Force during World War II.

BECCO CHEMICAL DIVISION, Food Machinery and Chemical Corp., Buffalo, N. Y., has promoted **Ralph J. Gall** to assistant manager of Organic Research and Development.

Gall received an M.S. degree in chemistry from Canisius College in 1947. He joined Becco in January 1947 as a member of the Research department and has held the position of group leader, Organic Research and Development, since January, 1954.

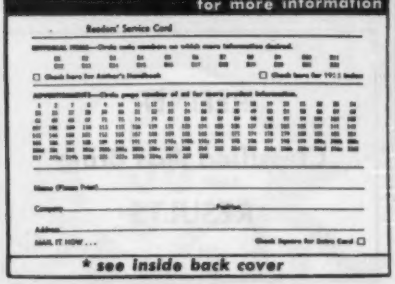
CHASE BRASS & COPPER CO., a subsidiary of Kennecott Copper Corporation, has promoted **G. C. Van Heusden** to district manager of their new New York warehouse and office. Van Heusden succeeds **Herbert H. Bartlett,** who retired February 1 after 31 years of service to Chase.

A native of Brooklyn, N. Y., Van Heusden has been associated with Chase since 1925, virtually all of the time in sales activities. His first position was at the old Chase New York office, where he worked seven years. He was transferred to Newark, N. J., in 1932 and six years later was made manager there. Then under the direction of the New York office, Van Heusden continued as district manager in Newark when that office was made independent of New York in 1943. In July, 1955, he was transferred to New York as assistant district manager.

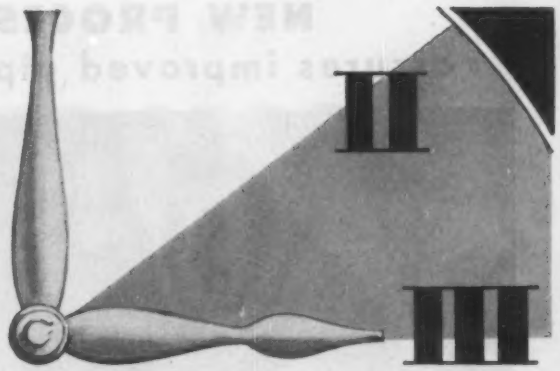
UNITED STATES RUBBER CO., Naugatuck Chemical division has appointed **Gerald L. Dennis** manager of field sales. Dennis, formerly Los Angeles district manager, will in his new post supervise the transition of Naugatuck Chemical's commodity sales organization to a district sales office set up. He will then promote sales of all the chemical division products through this district organization.

A graduate of Nebraska State Teachers and Colorado College of Education, Dennis joined Naugatuck Chemical in 1942 as a

use these
READERS' SERVICE CARDS*
for more information



* see inside back cover



There's Just One Thing We Have to Sell—
TIME!

Once you accept Time as the priceless commodity it is, our selling job is done. The urge to judge the Pump you buy on the basis of an attractive price tag may be out of all proportion to its true significance. The price advantage disappears in a hurry in the face of hours lost waiting for materials to get to pumpable consistency . . . down-time for extra cleaning and repairs . . . man hours and machine production lost because of a cheap pump! Yes, to make Time buy you more, get—

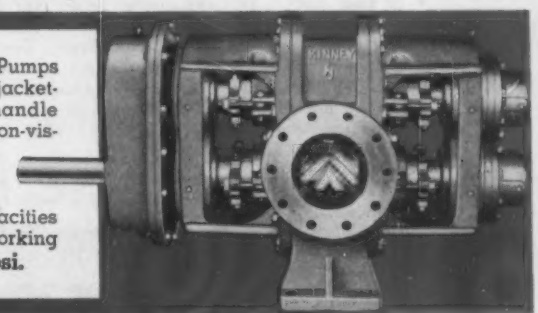
Kinney®

HELIQUAD ROTARY PUMPS

The HELIQUAD Pump is not to be confused with ordinary gear pumps. Its superior suction lift and pumping characteristics stem from definite design advantages. The HELIQUAD design features substantially larger cavities to draw in and push along the material pumped.

The entrance chamber to the pump is large . . . the entrance chamber into the void between the working parts is large . . . hence it is easy for the KINNEY HELIQUAD to out-perform other mechanisms when you have a tough suction job.

KINNEY HELIQUAD Pumps in plain and steam-jacketed configurations handle heavy viscous and non-viscous materials . . . gas oils, asphalt, tars, waxes, crude oil or gasoline. Capacities to 2500 gpm . . . working **pressures to 350 psi.**



WRITE . . .

Get all the facts on the rugged, versatile and Money-Saving HELIQUAD Rotary Pumps.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3596E WASHINGTON STREET • BOSTON 30 • MASS

Kindly send me Bulletin No. L51A illustrating and describing KINNEY Liquid Handling Pumps.

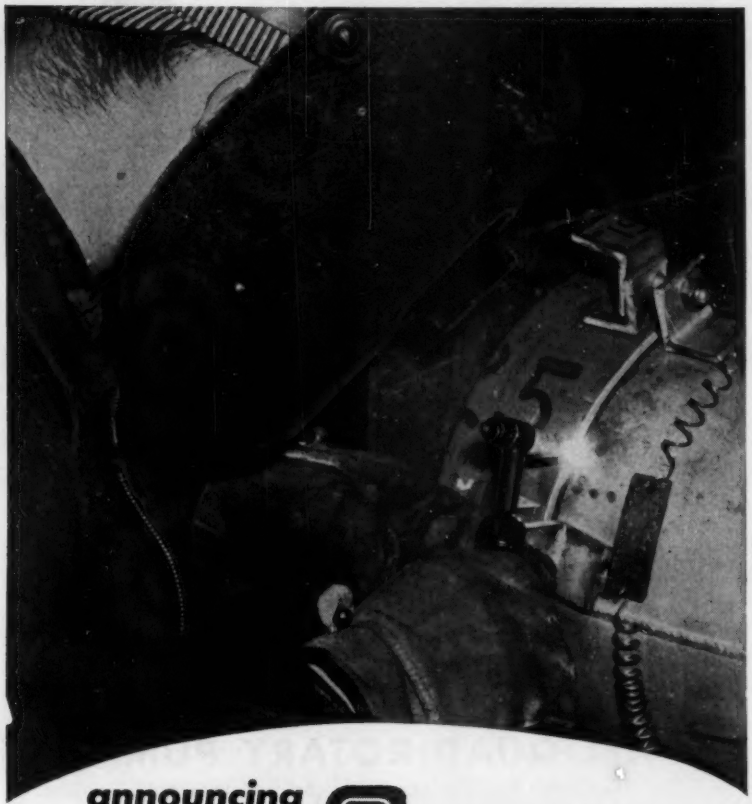
Name_____

Company_____

Address_____

City_____ Zone_____ State_____

NEW PROCESS
assures improved pipe welds

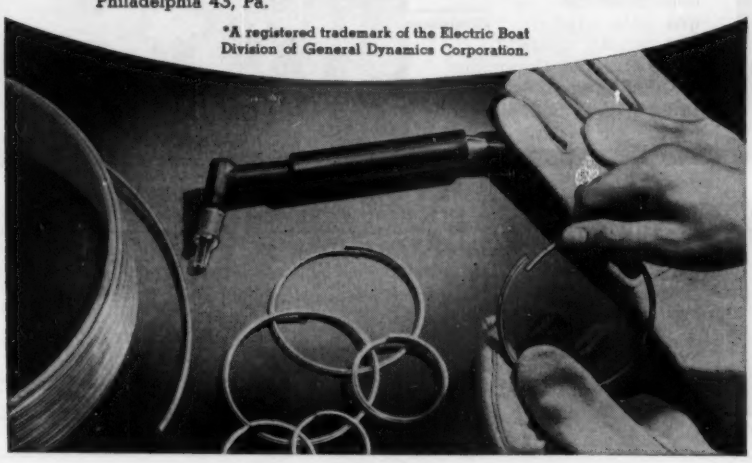


announcing the **ARCOS**

EB* WELD INSERT

To meet modern requirements for better pipe welds where high temperature, high pressure, and corrosive conditions exist, Arcos now offers the Consumable Weld Insert. Used for making the root pass, the EB Insert assures sound crevice free welds with smooth uniform inside contours. Saves money and time in fabrication . . . minimizes turbulence, and promotes trouble free service. Write for details. ARCOS CORPORATION, 1500 S. 50th St., Philadelphia 43, Pa.

*A registered trademark of the Electric Boat Division of General Dynamics Corporation.



Suppliers . . .

training supervisor at the Kankakee Unit of the Joliet Arsenal, Ill. In 1945 he was transferred to the main plant in Naugatuck, Conn., as a senior research chemist.

In 1947 he joined the sales department and was assigned to the Philadelphia area as technical sales representative. In 1952 he was sent to Los Angeles as district manager, supervising sales of the division's latex compounding plant in Los Angeles, and warehousing for the Western states.

WALWORTH CO. has named **John C. Wallace** vice president of engineering, Fred W. Belz, president, announced. Wallace was formerly vice president and general manager of Hunt-Spiller Manufacturing Corp., Boston.

A Yale graduate, Wallace served as a lieutenant in the Navy in World War II. He was previously associated with Lima Hamilton Corp. and the Bessemer & Lake Erie Railroad.

HERCULES POWDER CO. re-elected all officers and members of the executive and finance committees for the ensuing year at the annual meeting of the board of directors.

In addition, **E. C. Stump III** was elected assistant secretary, and **Alto J. Smith** was elected assistant treasurer.

Stump has been administrative assistant to the secretary of the company since September 1955. He joined Hercules in 1941 as a clerk in the Explosives department, and became office manager of the Personnel department in 1946.

Smith has been in the Administrative division of the Treasurer's department since December 1956. He joined Hercules in 1927 and was made assistant credit manager of the company in 1941.

THE PFAUDLER CO. has appointed **Willard D. Clark** district sales representative in the New England area.

A graduate chemical engineer from Northeastern University, Clark has more than 15 years experience in sales and sales engineering. Prior to joining The Pfaudler Co. in November 1956, he was associated with Colgate-Palmolive Co. and MacAlaster Bicknell Co. Clark will conduct joint sales activities with M. J. Goodwin from Pfaudler's Boston area office.

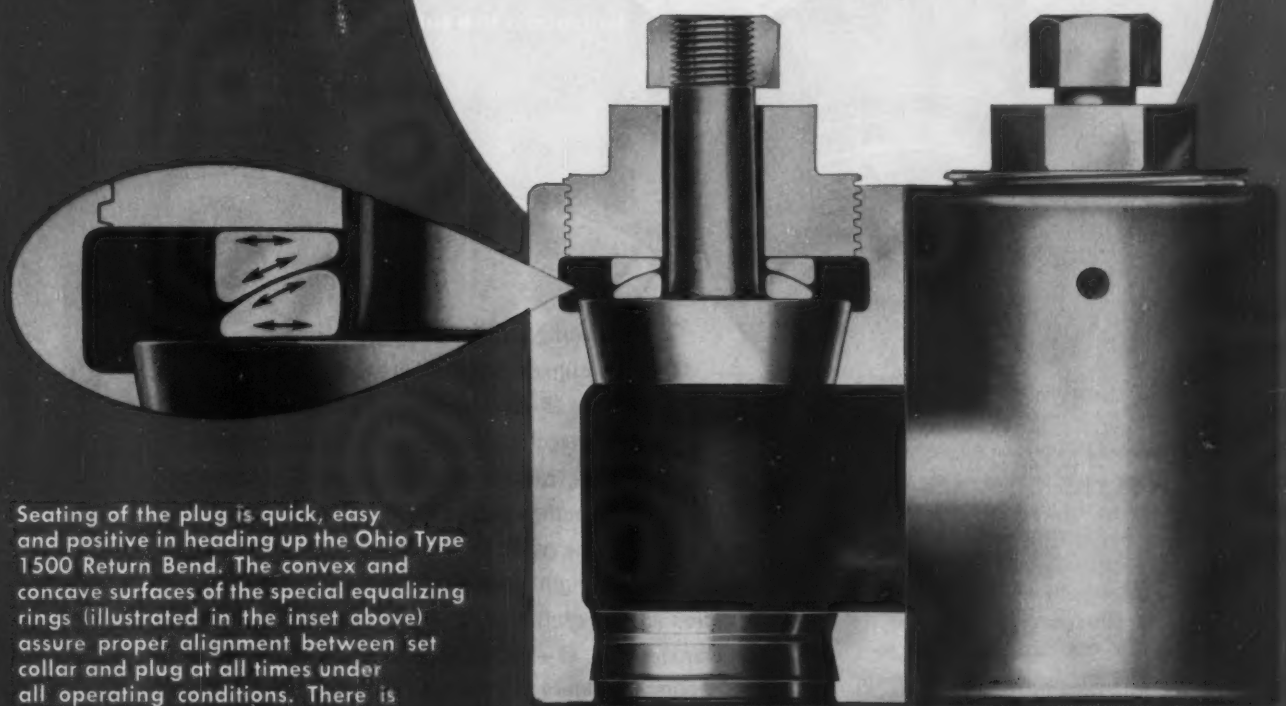
STAYTITE CO. announced that at the annual meeting of the stockholders and directors in Houston recently, **H. J. Glauser, Jr.**, was elected president; **F. G. D. Muller**, vice president; **Wharton E. Weems**, secretary; and **C. C. Glauser**, treasurer.

DAVISON CHEMICAL CO. has announced completion of a new plant, erected at a cost of $1.5 million at Curtis Bay, Balti-

REFINER
Classified Ads Bring
RESULTS

Ohio TYPE 1500 RETURN BENDS

flexibility of holding mechanism insures QUICK, POSITIVE plug alignment



Seating of the plug is quick, easy and positive in heading up the Ohio Type 1500 Return Bend. The convex and concave surfaces of the special equalizing rings (illustrated in the inset above) assure proper alignment between set collar and plug at all times under all operating conditions. There is exceptional strength of closure design with uniform stress in tension and shear about holding mechanism and body. To assure easy removal, the Type 1500 Return Bend has a floating set collar which eliminates thread galling and/or thread seizure.

Other plus features of the Ohio Type 1500—*SELF-CONTAINED CLOSURE MECHANISM* in which all parts handle as a unit for faster heading up or unheading . . . *POSITIVE PLUG PULLER DEVICE* incorporated in closure mechanism eliminates need for special pulling tools . . . *GREATER SAFETY* because plug cannot blow out; trapped gases are relieved through weep-holes while set collar is still engaged . . .

OUR 50th YEAR 1907 1957

***FOUR SERIES*—850, 1275, 1700 and 2000, with ten sizes in each series (2" to 6⅝").**

THE OHIO STEEL FOUNDRY CO.

SPRINGFIELD, OHIO

Plants at Springfield and Lima, Ohio

ORBC

you can judge

the comparative values of furnace design as applied to operating requirements.

It's quite simple

there are 9 basic factors which must be evaluated to obtain the full comparison of values

1—Average radiant transfer rate. **2**—Maximum deviation from average radiant transfer rate. **3**—Average and maximum transfer rate in convection section. **4**—Maximum tube wall temperature, radiant or convection. **5**—Maximum efficiency with specified excess air. **6**—Controlled thermal recirculation of flue gases to provide even heat distribution throughout full length of each tube and equalized heat distribution around each tube. **7**—Overload and corresponding transfer load. **8**—Design to provide: structural column supports - Ladders - Platforms - Tube Removal facilities, etc. **9**—Degree of assembly; of the furnace structure and of the heating surface.

Whenever all these 9 specifications are applied to all the operating requirements, you can be sure PETROCHEM ISOFLOW FURNACES will be found most economically desirable.

No other furnace design can claim the recognition and acceptance achieved by PETROCHEM ISOFLOW FURNACES . . . starting with one installation in 1940, January '57 records more than 1650 ISOFLOW FURNACES in operation and under construction—a record that is incomparable just as all Petrochem Isoflow furnaces are more economically desirable by any comparison.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES:

Bowen & Co., Houston • Wm. H. Mason Co., Tulsa • Lestre Oberholtz, Los Angeles • Pavillo-Levelly, Chicago • D. D. Foster, Pittsburgh • Turbex, Philadelphia • Flagg, Brackett & Durgin, Boston • G. M. Wallace & Co., Denver & Salt Lake City

International Licensees and Representatives: SETEA-S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentina • Industrial Proyectora, Caracas, Venezuela • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge, Liege, Belgium • Heurtey Italiana S.P.A., Milan, Italy • Birwelco Ltd., Birmingham, England

Suppliers . . .

more, to produce reforming catalyst for petroleum refineries.

Capacity of the new facility is approximately double that originally projected. In the course of construction, demand for the product developed so rapidly that plans were revised for additional production. There was a partial start-up in early summer of 1956, followed this year by full operation.

The reforming catalyst is platinum on alumina.

DIAMOND ALKALI CO. has announced the promotion of **John P. Hyde** to the newly-created position of operations manager for the company's Silicate, Detergent Calcium division.

At his new post, Hyde will hold responsibility for production operations of the division's seven plants. He will be located at Diamond's headquarters in Cleveland.

Assistant manager of the Jersey City Silicate Plant since February, 1956, Hyde was previously staff process engineer at the company's Cincinnati plant. He joined the Diamond organization in April, 1951, following four years with another chemical producer.

A World War II veteran and a chemical engineering graduate of Worcester Polytechnic Institute, Worcester, Mass., Hyde is a licensed professional engineer in Ohio.

WORTHINGTON CORP. has established a new post of general sales manager and three new regional sales headquarters by its Mason-Neilan division.

A. Blair will become general sales manager of the Mason-Neilan division. Powell graduated from the University of Pittsburgh in 1934 with a BS degree, served as a chemical engineer for the Liberty Powder Co., a chemist for Southern Steel Wheel and in 1937 joined the Mason-Neilan organization as a sales engineer in the Pittsburgh office. He has been active in the chemical, oil and paper Industries and in contributing to the advance of automatic control in these fields. In 1947 he

Be Sure To Check This Month's Classified Section in REFINER

Need Engineers - Technical Personnel? Try a Classified Ad in Petroleum REFINER.

QUICK! ECONOMICAL! RESULTFUL!

Help Wanted! Classified Ads in Petroleum REFINER get the job done.

850 tubes rolled in less than 5 hours!

AIRETOOL Automatic Tube Expansion Control System simplifies and speeds accurate tube rolling!

A large coppersmithing company* recently faced one of the biggest tube rolling and expanding jobs of its kind when they had to roll 850 4 in. OD x 13 gage copper tubes in a limited time. Using AIRETOOL'S Automatic Tube Expansion Control System, they rolled those tubes at a rate of one every twenty seconds . . . completed the job in *less than five hours!*

You too, can shorten tube rolling time immensely . . . eliminate costly over-rolling, over-expanding and distortion of tube sheets . . . with AIRETOOL'S Automatic Tube Expansion Control System. Ask for an ON-YOUR-JOB demonstration, today. *Name upon request

SOLVE ALL YOUR TUBING PROBLEMS, FROM INSTALLATION TO REMOVAL, WITH AIRETOOL TUBE MAINTENANCE EQUIPMENT

CONDENSER CLEANERS

Outside mounted . . . direct or gear driven. Powerful . . . fast . . . lightweight. Clean lightly scaled or completely plugged tubes to 1". Built-in flushing system cools drill, removes chips.

CONDENSER TUBE EXPANDERS

Parallel rolling . . . self-feeding . . . ball bearing thrust collar. Roll tight accurate tube joints to uniform expansion and tightness with maximum bonding.

TUBE CLEANERS

Powerful . . . fast cutting . . . quickly, completely remove hardest deposits. Air Driven motors in wide range of sizes and speeds.

Write for illustrated literature, (Bulletin 60), showing AIRETOOL'S complete line of tube maintenance equipment.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

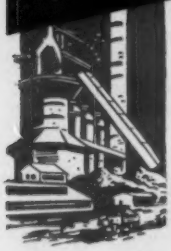
BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.

EUROPEAN PLANT: Vlaardingen, The Netherlands. CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario.

AMOCO

WILL ACHIEVE
lower maintenance
AND
operating costs
AT THEIR REFINERIES

with the
Alumicoat
molten aluminum process



The Alumicoat Molten Aluminum Process will substantially reduce down time and expense for repairs and replacements by preventing high temperature hydrogen-sulfide corrosion and scaling in hydro-desulfurizing equipment.

In addition, costs will be reduced further by the use of low cost, low alloy steels which, when "ALUMICOATED", obtain the necessary resistance to high temperature hydrogen-sulfide corrosion.

Send coupon today for full details.

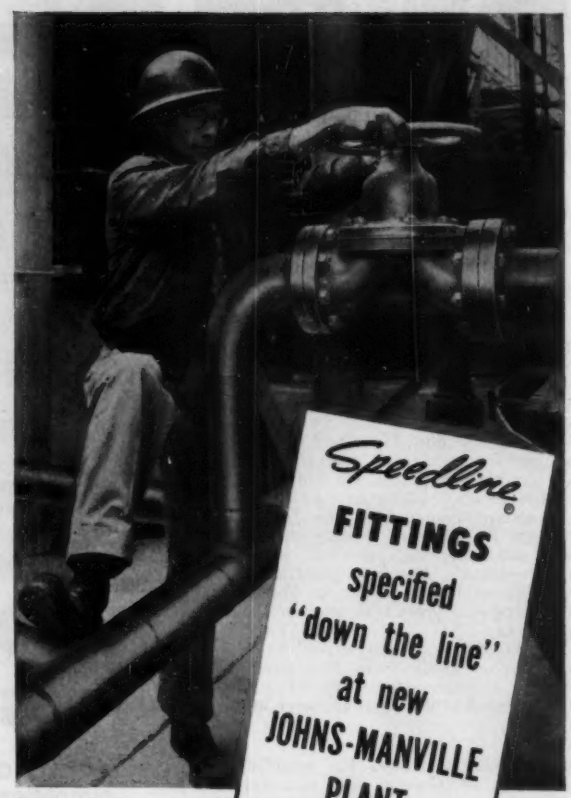
Arthur Tickle Engineering Works, Inc. Dept. 12
21 Delevan Street
Brooklyn 31, New York

Please send ALUMICOAT brochure and complete information on the ALUMICOAT PROCESS.

Name_____

Address_____

City_____ **Zone**____ **State**_____



Process pipeline system at Johns-Manville Corporation's "Synthetic Silicates" Plant, Lompoc, California.

PROBLEM: To select the best pipe and fittings to withstand corrosive action of sulphuric acid, occasionally mixed into low ph slurry lines. Process piping system is used in manufacture of Micro-Cel® . . . where corrosion would contaminate product quality, result in costly leaks and pipe replacements, as well as impede flow rate and increase pumping horsepower requirements.

SOLUTION: Consideration of materials costs, ease of installation, labor costs and length of service life, made choice of stainless steel system obvious. Speedline Fittings and economical light wall stainless pipe met *every* job requirement . . . were specified for *entire* plant process piping system!

Speedline Fittings are made in a variety of analyses especially for use with Schedules 5 and 10 stainless pipe. An illustrated brochure describes how Speedline Fittings with exclusive "tangential feature" simplify pipeline assembly . . . provide bonus advantages down the line for your process operations.

Write for your copy of The Speedline Catalog without obligation . . . or contact the Speedline distributor nearest you.

Speedline®

708R

®REG. T.M.

STAINLESS STEEL FITTINGS
THE NEWEST THING IN PIPELINE ECONOMY
SPEEDLINE DISTRIBUTORS ARE LOCATED IN PRINCIPAL CITIES FROM COAST TO COAST

Manufactured by **HORACE T. POTTS COMPANY**
566 E. Erie Avenue • Philadelphia 34, Penna.

Suppliers . . .

was appointed manager of the Pittsburgh office.

The three new regional sales offices will provide increased services in key areas. **Warren F. Priest** has been appointed Eastern regional manager; **E. Putnam Head** Southeastern regional manager; and **Alex M. Thackara** West Coast regional manager. In addition, **Malcolm D. Duncan** has been appointed manager of a new Jacksonville office.

EVANS RESEARCH AND DEVELOPMENT CORP. has added four more chemists to its technical staff. **Harold E. Worthman,** from the Army Chemical Center and the graduate school of Brooklyn College, has joined the staff as research chemist.

New Junior Chemists are **Elinor M. Cohen,** a graduate of New York University, where she was American Institute of Chemists Student Medalist; **Frances E. Goldenson,** a graduate of the University of Virginia, and formerly of Fisher Scientific Co.; and **Charles John Coreschi,** a graduate of St. John's College.

GRAVER TANK & MFG. CO., INC. has elected **E. N. Gosselin** chairman of the board and **J. E. Swanson** president.

Gosselin has been president of Graver since 1930. J. E. Swanson started as foreman in the East Chicago plant and has served in the shops, in sales and in management. He has been executive vice president since 1948.

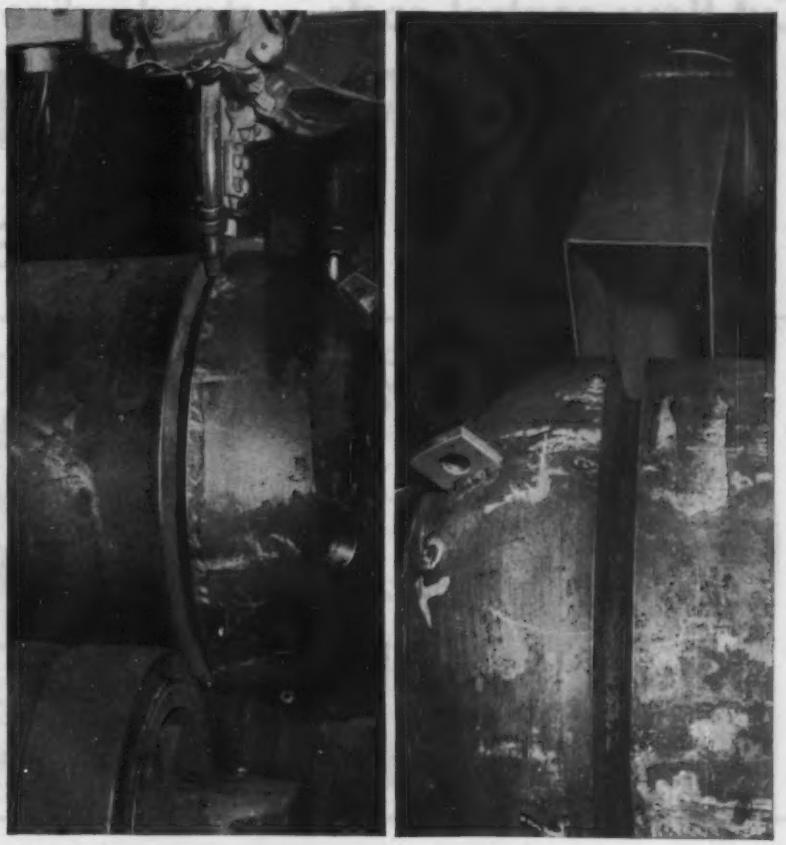
HOOKER ELECTROCHEMICAL CO. has promoted **William L. Gillespie** and **John T. Walmsley** to new posts in the sales department. Gillespie formerly manager, Chicago district sales, now assumes the new title of manager, sales administration. Walmsley, formerly Hooker sales representative for the Michigan and northern Indiana territory, will replace Gillespie as manager, Chicago district sales.

Born in Springfield, Mass., Gillespie received the B.A. degree from Alfred University in 1939 and came directly to Hooker, first as a chemical process operator and then as operating foreman in the research and development department. Transferring to the sales department in 1950, he served with the technical service group, then as a sales representative, and in 1953 was named manager, Chicago district sales.

Walmsley is a native of Alabama and received the B.S. degree in 1948 and his M.S. degree in 1950 in chemical engineering from Virginia Polytechnic Institute. Joining the company at Niagara Falls in the process study group in 1950, Walmsley was appointed an assistant sales engineer at Hooker's Tacoma, Wash. plant in 1950, returning to Niagara in 1952 for a year as a sales coordinator until being made Michigan sales representative.

ARIZONA CHEMICAL CO. has appointed **Bart F. O'Brien** sales representative. His territory will include part of New Jersey, New York and the New England States.

Over the past 8 months, O'Brien has been undergoing training at the processing facilities of Arizona Chemical at Panama City, Florida and New York City headquarters. Prior to joining Arizona, O'Brien worked for American Can Co., and the



WELDING... X-RAYING...

2-inch-thick seam at Downingtown

Item: Air Dryer Cylinder
Material: Carbon Steel
Thickness: Head, 2"—Shell, 2-5/16"
Design Pressure: 3200 psi
Hydrostatic Test Pressure: 5400 psi
Design Temperature: 450° F.
Stamping: National Board and ASME

X-rayed and stress relieved. Inspection by purchaser and Hartford. One of 8 identical units. The rest of our plant equipment is geared to our capacity for welding 2-inch-thick material and lifting 80 tons. Write for bulletins; illustrating Downingtown equipment and experience.

Downingtown Iron Works, Inc.
151 Wallace Ave., Downingtown, Pennsylvania
division of PRESSED STEEL TANK COMPANY Milwaukee
Branch offices in principal cities
HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

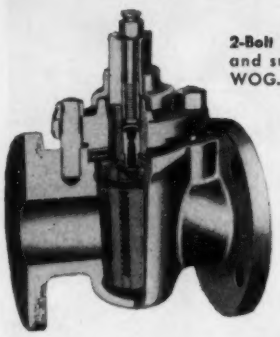
For more data on advertised products, use Readers' Service Cards, last page.

Cut flow control costs... standardize on...

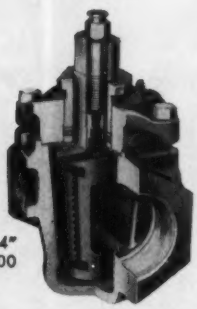
THE WORLD'S MOST COMPLETE

LUBRICANTS and

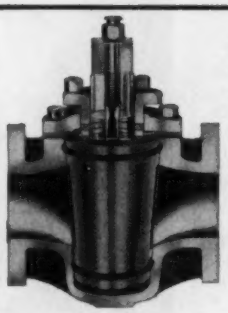
VALVES



2-Bolt Cover Type Valve in 4" and smaller sizes for 175-lb WOG. *Semi-Steel*

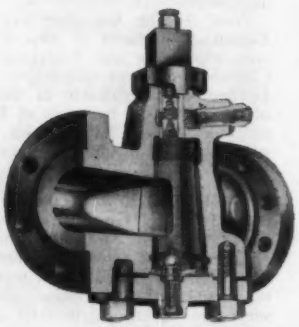


Screwed Gland Type Valve in 4" and smaller sizes for 200, 400 and 500-lb WOG. *Semi-Steel*



Bolted Gland Type Valve in 4" to 36" for 200 through 800-lb WOG Semi-Steel and ASA 150-lb and 300-lb Carbon Steel.

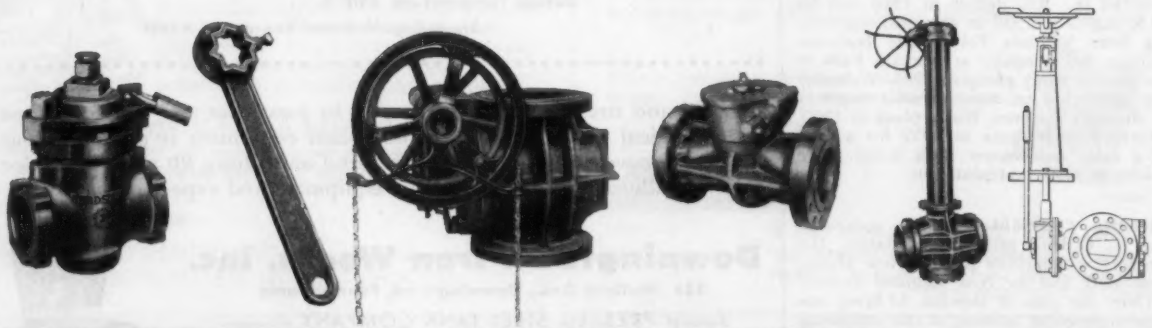
Hypreseal Valve—Bolted Bottom Cover Type. ½" to 30 by 34" for ASA 150-lb through 1500-lb Carbon Steel (with rectangular opening). API 2000-lb and 3000-lb WOG Alloy Steel Rectangular Opening. API 2000 and 3000-lb WOG Alloy Steel (with round opening).



LUBRICANTS

PROPER VALVE LUBRICATION means longer valve life and better performance at lower cost. Rockwell is the world's oldest and most experienced manufacturer of lubricated plug valve lubricants. To assure perfect performance, a *complete line* of lubricants has been developed and field proved. For convenience, they are available in stick, tube and bulk forms. The Rockwell High Pressure Booster Type Hand Gun and Rockwell High Pressure Booster Type Bucket Gun make the lubrication of even a great number of valves a job that takes only minutes.

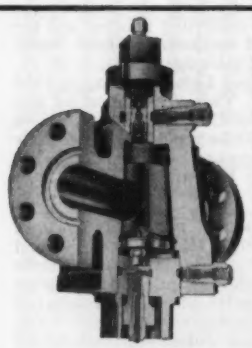
ACCESSORIES



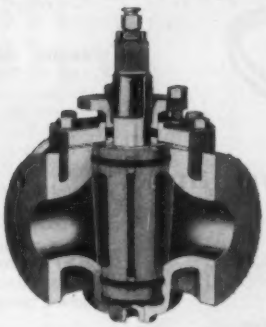
GREATER DESIGN AND INSTALLATION FREEDOM are the "extras" you get when you specify Rockwell-Nordstrom valves and accessories. No matter what your operating requirements or problems, you can select from a *complete* line of valve accessories that assure easier, safer, more efficient operation. While only a few of the valve accessories are shown above, you can learn about the complete selection by talking with your Rockwell-Nordstrom sales engineer or writing directly to: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania.

LINE OF LUBRICATED PLUG VALVES,

ACCESSORIES



Hypreseal Valve—Screwed Bottom Cover Type. ½" to 8" for 7500-lb WOG Alloy Steel (rectangular opening). ASA 2500-lb Carbon Steel (rectangular opening). API 5000-lb and 10,000-lb WOG (rectangular opening) and API 5000-lb and 10,000-lb WOG (round opening).



Multiport Valve Type. Available in Gland type and Hypreseal type in WOG pressures to 400 lb and ASA pressures to 1500-lb. Sizes from ½" to 24".

ALL THESE ADVANTAGES
In *Every* Rockwell-Nordstrom Valve.

LEAKPROOF: Lubricant sealing is a *double* seal against leakage.

LONG-LIFE: Lubricant prevents metal-to-metal wearing friction.

LOW-COST: Lubrication is preventive maintenance.

DEPENDABLE: Hydraulic lubricant action jacks plug for instant operation.

QUARTER-TURN OPERATION: 90° turn for *full* positive shut-off.

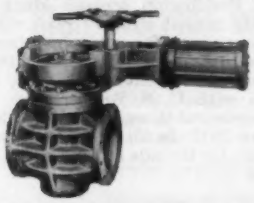
SMOOTH PASSAGE: Straight-through flow without crevices . . . minimum pressure drop.

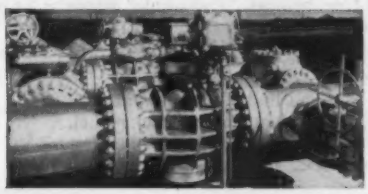
UNEXPOSED SEATS: Corrosion and erosion eliminated in vital seat areas.

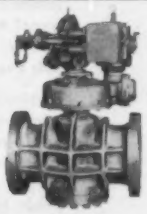
ADJUST, LUBRICATE UNDER PRESSURE: Never down time for routine servicing.

No other valve—at any price—can offer the performance and longer life at lower cost of Rockwell-Nordstrom valves.

POWER OPERATORS



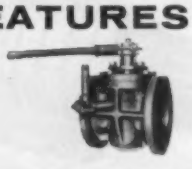


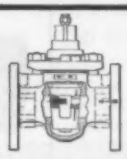


AUTOMATIC VALVE OPERATION is more dependable and economical when you specify Rockwell-Nordstrom valves. They are far superior to ordinary valves for power operation because *lubrication* reduces operating torque—smaller, less costly actuators can be used. And since there are no forced, wedged seats to be set, the actuator has only to move the lubricated plug through 90°.

Typical electric, pneumatic and cylinder operators shown above represent only three of the more than fourteen power operation arrangements available.

VALVES WITH SPECIAL FEATURES





NO MATTER WHAT YOUR NEEDS, there is a Rockwell-Nordstrom valve that will do the job better, longer and at lower cost. A few of the Rockwell-Nordstrom valves with special features are shown above.

Special metal valves are available in stainless-steel, bronze and other corrosion resisting alloys for even the toughest services. Valves with *hard faced plugs and bodies* combine the economy of semi-steel with hard facing for utmost corrosion and wear resistance. *Steam jacketed valves* for precise product temperature control. *By-pass relief valves* prevent pressure build-up that imposes dangerous stress on ordinary valves and fittings. *Gas safety control (Factory Mutual) valves* for positive control against explosion in multi-burner gas-fired furnaces, ovens and driers.

* * * *

Rockwell-Nordstrom valves and accessories are available at leading oil field and industrial distributors everywhere. For full information write: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

Lubricant Sealed For Positive Shut-off

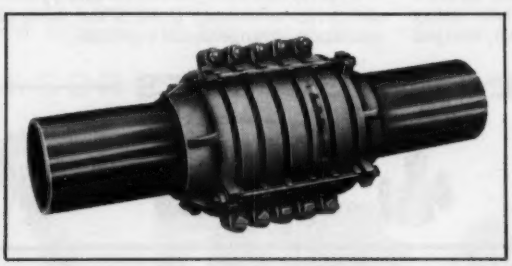
19,862 years of precision metal-forming

Time brings experience . . . experience brings skill . . . and the FLEXON® team of engineers, metallurgists, and technicians have worked a total of **19,862** years perfecting the most skillfully-made expansion joints that can be formed.

These same skills are part and parcel of all Flexonics formed and corrugated tubular shapes in metal—flexible metal hose, instrument-type bellows, "impossible" bends and section modulations for aircraft parts. They assure you expansion joints that you can **install and forget.**

Always specify FLEXON Expansion Joints—free-flexing and controlled-flexing; dual and multiple types; balanced joints and other special designs; all in stainless steel, monel, and other workable alloys. Flexon Expansion Joints last longer on the job—because they are engineered right and made better.

Write today for your copy of the Flexon Expansion Joint Design Guide—28 pages of facts about absorbing pipe motion.



EJ-208

Flexonics
corporation

EXPANSION JOINT DIVISION— 1336 S. THIRD AVE., MAYWOOD, ILL.

EXPANSION JOINTS | METAL HOSE | NON-METALLIC HOSE | BELLOWS | AIRCRAFT COMPONENTS

Suppliers . . .

General Motors Corp., in truck sales. He is a Navy veteran of World War II and a graduate of the University of Notre Dame, having received his B.S. degree in 1949.

LAMSON CORP., Syracuse, N. Y., has appointed **Gifford Kittredge** as manager of Commercial division. Kittredge will be responsible for all sales and related activities of Airtubes and commercial conveyor systems. His duties will also include the development of marketing policies, and the co-ordination of engineering, field installations and field sales operations.

Kittredge joined Lamson Corp., in 1946 as an engineer. Two years later he was transferred to the Chicago office as a field engineer. In 1953 he was promoted to New York regional manager.

Kittredge is a Harvard graduate.

WAGNER BROTHERS, INC., has named **Frank M. Mansfield III** sales manager and vice president. Mansfield was formerly manager of product planning and market research for General Electric's Metallurgical Products department, Detroit.

Mansfield's new duties will include directing the company's field sales force and distributors. Mansfield at one time was associated with the Torrington Co., both as sales manager of the Cincinnati district, and as Detroit district engineer. He joined General Electric in Detroit as manager of product programming in 1954.

UNITED STATES RUBBER CO. has appointed **William J. Reddington** St. Louis district sales manager for the mechanical goods division. Reddington replaces **Hugh Reynolds,** who retired after 30 years with the rubber company. Reynolds had been St. Louis district sales manager since 1944.

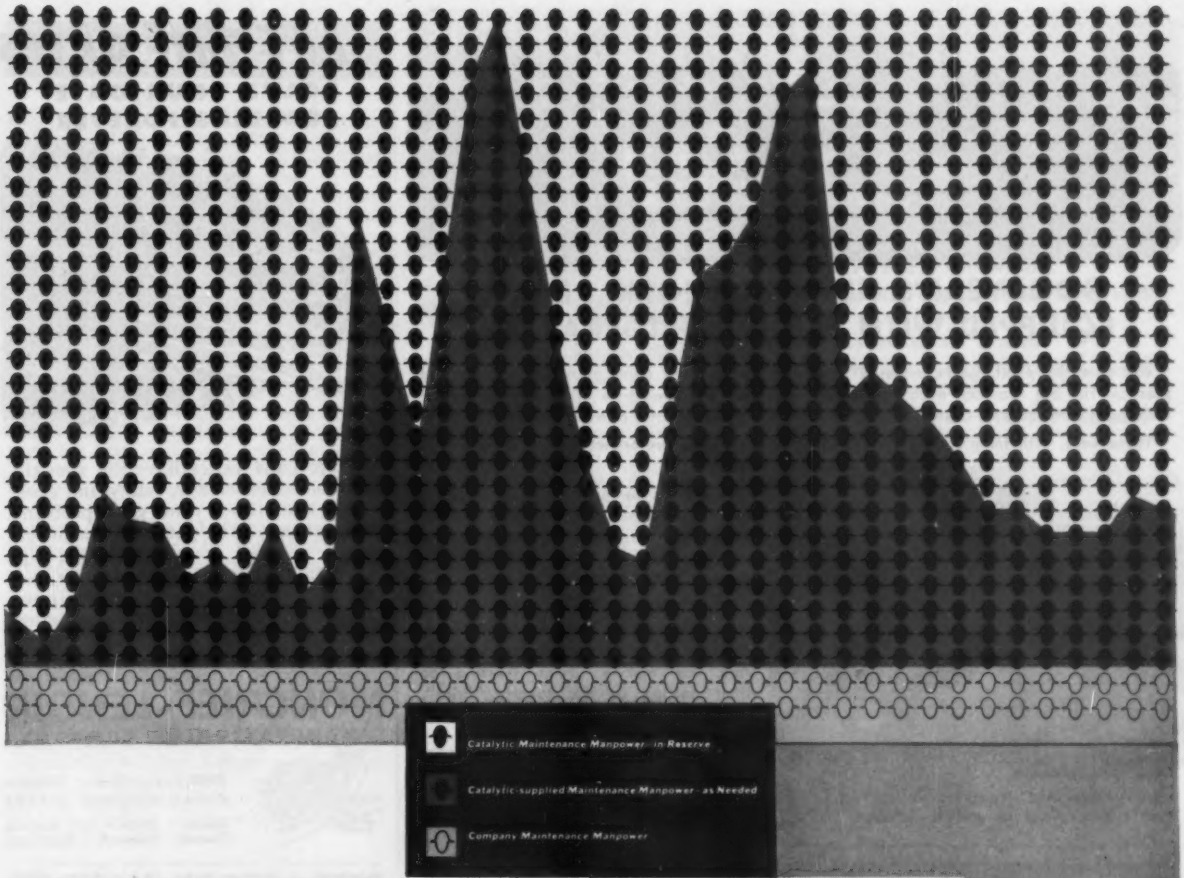
Reddington, a native of Passaic, N. J., has been with U. S. Rubber since 1933, and a member of its mechanical goods sales staff since 1937. In his new post he will be responsible for the sale of mechanical goods products.

UNITED STATES STEEL CORP. has appointed **Howard Rainbird** city representative at Edmonton, Alta, Canada for the company's Oil Well Supply division. Rainbird was employed by "Oilwell" in 1947 at Calgary, Alta, Can. In 1949 he was appointed field representative at Edmonton, Alta., Can., the position he held prior to his present appointment. A native of Manitoba, Can., he served in the Army during World War II.

VAPOR RECOVERY SYSTEMS CO., Compton, Calif., is doubling the area of its electronic department and completely modernizing it. Latest industrial lighting and air conditioning are being installed to insure ideal conditions for the production of sensitive electronic devices.

A new laboratory fitted with the latest in research and testing equipment has been built.

MISSION MANUFACTURING CO. sales representatives from the company's Mid-Continent district reviewed sales plans and made additional plans when they met recently in Tulsa, Okla. Those attending the meeting were Jim Buxton, Tulsa; Bob Wood, Mount Carmel, Ill.; Paul Chisholm, Great Bend,



HOW HIGH ARE YOUR MAINTENANCE COSTS?

This graph of the actual maintenance manpower load of an operating facility demonstrates how *Catalytic's Contract Maintenance Service* can lower production costs in modern process plants.

This service provides . . .

Stabilization of plant employment . . .

Additional skilled labor when needed . . .

Release of management from costly supervision of non-profit phases of the operation . . .

Easier control of maintenance costs . . .

Measurable savings in dollars.

Catalytic's flexible supporting work force responds to peak-and-valley maintenance manpower needs.

Whether you want to assure minimum maintenance manpower costs in an operating plant . . . or to establish flexible, economical maintenance in a new plant . . . you will find *Catalytic Contract Maintenance Service* means more profit and less operating expense.

CATALYTIC

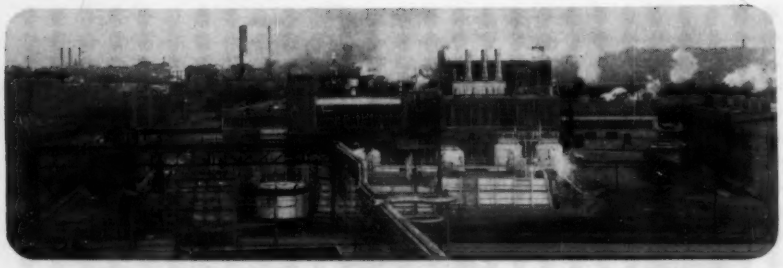
CONSTRUCTION COMPANY

Philadelphia 2, Pennsylvania. Toledo, Ohio

In Canada Catalytic Construction of Canada, Limited; Sarnia, Ontario; Toronto, Ontario; Montreal, Quebec

CATALYTIC ON-TIME . . . ON-BUDGET SERVICES for the atomic energy, chemical, petrochemical and oil refining industries • Project Analysis • Process Design • Economic Studies • Engineering • Procurement • Construction • Plant Operation

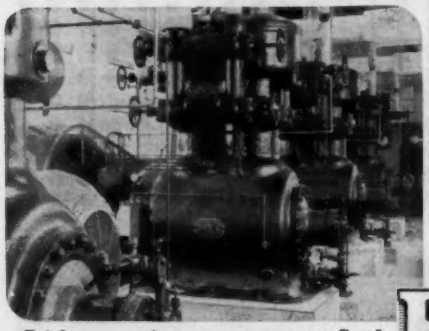
For more data on advertised products, use Readers' Service Cards, last page.



GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

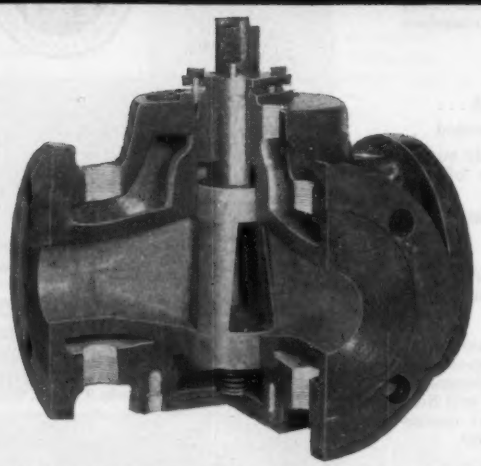
When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick". Literature and estimates on request.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U. S. A.

H&B ESTABLISHED 1887

Jacketed Spring Loaded PLUG VALVES

- 2-WAY OR STRAIGHT SPRING LOADED
- 3-WAY SPRING LOADED
- ANGLE SPRING LOADED
- AIR CYLINDER OPERATED SPRING LOADED—*all sizes and types*



LONG ON SERVICE . . . SHORT ON MAINTENANCE

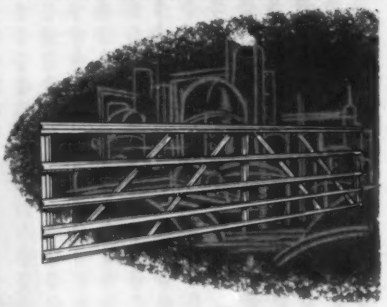
H & B's new fully jacketed spring loaded plug valves feature an inverted tapered plug inserted and lapped into the housing from the bottom of the valve—then spring loaded. The spring wedges the plug to a perfectly tight seal, eliminating troublesome leaks. Easy to operate—no big handwheel . . . no freeze . . . no "breaking loose" necessary. Easy to clean. Made in two port or multi port design, with any special stop arrangement desired.

Bulletin J-57 sent on request

HETHERINGTON & BERNER INC., 747 Kentucky Ave., Indianapolis 7, Ind.

LIFE-TIME GATES

SOLVE YOUR GATE PROBLEMS FOREVER



Life-Time Gates have the strength, durability, efficiency, safety and economy that solve your gate problems permanently. The patented design features a rigid frame of rolled-edge corrosion resistant aluminum or galvanized steel. Specially designed hinges and latches are practical, compact and rugged. Order the original and genuine Life-Time Gate from . . .

MONCRIEF-LENOIR MANUFACTURING COMPANY

2103 Lyons Ave. • Houston
Phone CApitol 7-1441
Dallas • Waco • San Antonio
Temple • Lubbock • Harlingen

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

CONSTRUCTION MATERIALS
CARTER-WATERS
KANSAS CITY MISSOURI

2440 Pennway Phone GRand 1-2570

PRESUR-ITE

PNEUMATICALLY PLACED CONCRETE AND REFRACTORIES FOR

SUSPENDED WALLS ARCHES FOR PRESSURE VESSEL LININGS HEATERS • BOILERS

- INSULATION
- FIREPROOFING
- STACKS, BREECHINGS.
- REFRACTORY TURN AROUNDS.
- CONCRETE AND STEEL SANDBLASTING
- ENCASEMENT FOR PIPE LINES
- CONCRETE RESTORATION

Write for estimates on your proposed project

GEO. P. REINTJES CO.
REFRACTORY WORK SINCE 1920
2517 JEFFERSON ST. KANSAS CITY 41, MO.
NEW YORK • HOUSTON • PITTSBURGH

Suppliers . . .

Kan.; Byrom Wehner, Houston; Joe Young, Oklahoma City; Bud Boyd, Edmonton, Alberta, Canada; Mel Davis, Denver; and Norman Robertson, Casper, Wyo.

Also John Brown, Tulsa, district maneger; Miller Sparks, Houston, Industrial sales manager; Jack Stewart, Houston, assistant sales manager; Richard White, Houston, executive vice president and general manager; W. B. Sharp, Houston, president and chairman of the board; Ted Fullinwider, Houston, domestic sales manager, and Jack Brown, Marlow, Okla.

McCULLOUGH TOOL CO.'s Eastern division has announced that **Masterson Coyle**, former Eastern division fishing tool manager, has been appointed branch manager at Great Bend, Kan. Also **Ottis C. King** has been transferred from Oklahoma City, to Great Bend, Kan. as sales manager.

Prior to joining McCullough in 1953, Coyle was employed by Humble Oil and Refining Co. and Standard Oil Co. (New Jersey). He has had 36 years experience in the oil fields in the United States, South America and Mexico.

King has had 12 years of oil field experience and is a member of the American Petroleum Institute.

DRESSER INDUSTRIES, INC. has named **M. L. Talbert** chief engineer for Security Engineering division. Talbert replaces **Carl Lichte**, who was recently appointed to the staff of the Turbodrill division. In his new capacity, Talbert will coordinate field and plant engineering activities.

U. S. INDUSTRIES, INC., Axelson Manufacturing Co. division, has appointed D. D. **Blodgett** general manager of its St. Louis plant. Blodgett has been with Axelson since 1943, and prior to his assignment at St. Louis, was area sales manager, Petroleum Products, of the Rocky Mountain and Canadian areas.

THE LUKENS STEEL CO., world's leading producer of specialty steel plate, will begin construction of a new million-dollar physical testing laboratory.

Ground will be broken for the new laboratory within the next few weeks. The building and related facilities are scheduled to enter full operation at an estimated cost of $1 million, within 12 months after construction begins.

Upon completion, the new physical testing laboratory will be fully equipped with the latest devices for testing the hardness, toughness, strength, elasticity, and internal quality of Lukens alloy and alloy-clad steel plates.

THE J. B. REA CO., Santa Monica, Calif., has announced the expansion of its computing service facilities.

The most recent addition to the analog simulation service is another unit of Electronic Associates which can be used separately or in combination with the present analog computer equipment.

ATLAS COPCO EASTERN, INC. has established a new division to sell and service the full line of Atlas Copco AB's stationary air compressors in the eastern United States.

Operations of the new division will be directed from Atlas Copco Eastern, Inc.'s general offices in Paterson N. J.

Why the NEW

Uniflow

bellows seal valve...is BEST

- **SEMI-STEEL** TOP WORKS
- TOP WORKS PROPERLY SIZED FOR VALVE BODY
- TOTALLY ENCLOSED SPRING
- BELLOWS SEAL—PLUS TEFLON PACKING FOR SAFE OPERATION
- REMOVABLE PLUG WITHOUT REPLACEMENT OF BELLOWS

High quality materials, engineering know-how and superior design assures long maintenance-free operation under many process conditions.

If you are now using valves with bulky top works and are experiencing corrosion and operational problems, check and compare UNIFLOW VALVES TODAY.

Requests for descriptive literature handled promptly. Write direct to . . .

UNIFLOW VALVE CORPORATION

19-B QUINE ST., CRANFORD, N. J.

U V C

MANNING & LEWIS ENGINEERING CO.
28-42 OGDEN ST. NEWARK 4, N.J.
WORKING PRESS:- SHELL TUBES
UNIT NO. JOB NO.

HEAT EXCHANGE and PROCESS EQUIPMENT

THIS NAMEPLATE IS YOUR GUARANTEE OF QUALITY

Condensers
Evaporators
Jacketed Kettles
Ribbon Mixers
Agitators
Reactors
Pressure Vessels
Heat Exchangers
Reboilers

ALL ALUMINUM AMMONIA COOLERS

A.S.M.E. Code stamped
Diameter: 36"
Length: 22'
Temperature: 250°F.
Weight: 14,000 lbs.

M & L engineers, drawing upon many years experience, designed, engineered and fabricated above unit to meet all the exacting service requirements set down in the specifications. This heat exchanger is all aluminum except the steel flanges on the heads and connections.

Three units of this size were furnished to a large Mid-Western Chemical manufacturer.

This is one more example why, at Manning and Lewis, we insist that; "Quality Comes First." Let us prove this to your satisfaction. Send for your copy of general bulletin 810, or better still, state all conditions of service for a prompt accurate proposal on the heat transfer equipment needed now in your plant.

Manning & Lewis *Engineering Company*
DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT
28-42 OGDEN STREET NEWARK 4, NEW JERSEY

M L

For more data on advertised products, use Readers' Service Cards, last page.

PETROLEUM REFINER Classified Ads

Petroleum Refiner New Classified Rates

RATES: **Regular Classified** (undisplayed) set in this size type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

HELP WANTED

■ PROCESS ENGINEER with two to five years' experience in refinery process work to fill position in newly organized Refining Division Technical Section. Work is of broad nature covering selection of processing steps and economic evaluation of processes. Unusual opportunity for advancement. Will pay moving and transportation expense. Liberal retirement, savings, insurance and health plans. Location—Bartlesville, Oklahoma. Replies will be held in confidence. Send resume of experience and salary requirements to Industrial Relations Division, Cities Service Oil Company, Bartlesville, Oklahoma.

PROCESS ENGINEERS

Design
Instrumentation
Development
(Methods & Data)

CAREER OPPORTUNITIES IN SOUTHERN CALIFORNIA

for men with experience in these fields for petroleum, petro-chemical, or chemical plants.

OFFERING MAXIMUM OPPORTUNITIES FOR:

Utilization & recognition of individual initiative & ability.
Broad responsibilities rather than narrow specialization.
Experience with a wide range of processes.

LIBERAL SALARY RANGES, PROFIT SHARING, TOP BENEFITS, & IDEAL WORKING CONDITIONS

Submit resume of training, experience, and work references to:

THE FLUOR CORPORATION, LTD.
ENGINEERS — CONSTRUCTORS
2500 S. Atlantic Blvd.
Los Angeles 22, Calif.

■ CHEMICAL ENGINEER - five years experience with major oil company in gasoline plant processing, design, operation and evaluation, now in staff position. Desires Independent—will consider gas processing—prefer opportunity in refining or petrochemical. Box 266-R, PETROLEUM REFINER, Houston, Texas.

HELP WANTED

Oil refinery experts of recognized standing for consulting work for french company with no foreign ties. Headquarters in Paris—one year or more contracts extendable—send resume and conditions désired to Contesse Publicité. No E 3846

20 avenue de l'Opéra
PARIS 1er qui transmettra

PROCESS ENGINEER

We urgently need a chemical engineer with 3-10 years refinery experience who has the ability to think for himself and work without close supervision. Job includes pilot unit supervision and startup of commercial refinery process units. About 30% travel.

Small aggressive engineering company that is on the move. Located in Houston, Texas.

Send complete details in first letter to:

Box 267-R
PETROLEUM REFINER
Houston, Texas

■ Graduate engineer experienced in process design, field construction and some engineering sales to take complete charge of expanding refractories linings division of nationally established Gunite Contractor. Specializing in refractory installations, insulating and fireproofing for refinery, gasoline and chemical plants. Salary commensurate with age, experience, and qualifications. Position available immediately. Send resume of education, experience and salary requirements. Inquiries confidential. 264-R, PETROLEUM REFINER, Houston, Tex.

FOR SALE

■ Oil pumps; 85 gpm @ 350 psi; Steam operated; Delaval; Located East Texas; Reasonable. Davenport 660 S. 5th, Louisville, Ky.

SITUATION WANTED

■ YOUNG ITALIAN ENGINEER, INDUSTRY SALES MANAGER in charge of the Italian Agency of an important American firm. Very well introduced in all industries especially chemicals and petroleum as well as Italian and foreign contractors. Wishes to contact important American or international firms interested in expanding their business in the European market, to be appointed resident engineer, general agent, representative, or factory manager for Italy, Europe and eventually Middle-East. Full details and references on request. Box 265-R PETROLEUM REFINER, Houston, Texas.

HELP WANTED

Petroleum Refinery Chemical Engineers

Positions involving technical service and consulting type work for petroleum refineries are available in refinery technology division. Chemical engineers working in refinery process engineering or operation and economic analysis are well qualified for these positions. Positions offer a wide variety of work assignments in an expanding technical activity that works with sales, research, refinery, and company management problems. Positions also afford opportunities for industry-wide contacts with refining and process companies and for using initiative and individual expression to increase responsibility. Location in a Detroit suburb offers ideal professional environment with a choice of city or suburban living. For more particulars send name and address to:

PERSONNEL MANAGER
ETHYL CORPORATION
1600 W. EIGHT MILE ROAD,
FERNDALE 20, MICHIGAN

Save on Your
INDUSTRIAL TRACK
FOSTER QUALITY
FULLY GUARANTEED
RELAYING RAILS
Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.
SEND FOR CATALOGS
RAILS - TRACK EQUIPMENT - PIPE - PILING
L B FOSTER co.
PITTSBURGH 30 • NEW YORK 7 • CHICAGO 4
ATLANTA 8 • HOUSTON 2 • LOS ANGELES 5

PROCESS ENGINEERS

For work in Tulsa, Oklahoma. Minimum requirements: B.S. degree in chemical or refinery engineering. Three to six years' experience in Process Design work relating to Chemical Plant and/or Petroleum Refinery Engineering and Construction.

Salary commensurate with educational background and experience. Furnish complete resume of experience with initial letter. Contact Glenn O. Hopkins, Personnel Manager, P. O. Box 1558, Tulsa, Oklahoma.

The Refinery Engineering Co.

Esso Expansion Now Requires

SCIENTISTS AND ENGINEERS—for Operations Research projects throughout the Jersey Standard interests. These involve the study of terminal operations, transportation, and inventory control problems. Such studies typically mean one or more field trips to collect basic data and to define the problem; analysis of the data to develop "mathematical models" of the problem; close work with the client to incorporate the results of these studies, and finally, follow up on the results.

Give full details of education, experience, desired salary, availability date and references. All inquiries will be considered promptly and held confidential.

Esso Research and Engineering Company

(Chief Technical Subsidiary—Standard Oil Company (New Jersey))

ESSO RESEARCH CENTER
Employee Relations-C
P. O. BOX 51 LINDEN, N. J.

Developments . . . Techniques . . . Ideas

POLYETHYLENE
By R. A. V. Raff and J. B. Allison

First organized account of all types of polyethylene. As far as possible in such a rapidly moving field, the book integrates structural observations, manufacturing conditions, properties and suitable fields of application. 564 pages, 1956 (High Polymers, Vol. XI).

228 illus.....Price $16.00

ORGANIC CHEMISTRY
By Louis and Mary Fieser

Third Edition of this important work. It develops in orderly sequence, the principles and concepts of modern organic chemistry and applications of the fundamental science to technology, bio-chemistry.

1150 pages, 1956...Price $10.00

Send for your Free Copy of
1956-57 PETROLEUM BOOKS CATALOG

THE CHEMISTRY OF PETROCHEMICAL REACTIONS
By Lewis F. Hatch

An immediate and valuable reference for those engaged in the chemical or refining industry.

192 pages, 1955.....Price $4.50

Order From: Book Department
The GULF PUBLISHING COMPANY
P. O. BOX 2608, HOUSTON 1, TEXAS

THE MILTON ROY CO., Philadelphia has announced the appointment of **Alfred E. Mohan,** Philadelphia, to its sales-engineering staff.

A graduate of Villanova University in 1954 with a B.S. degree in chemical engineering, he served over two years in the U. S. Navy as Ship's Engineering Officer. Prior to military service, he was employed at the Frankford Arsenal in polymer research and development.

His chief duties with the Milton Roy Co. will include the preparation of quotations and sales-engineering assistance for customers in the Midwest.

Mohan is a member of the American Chemical Society.

DAVIDSON-KENNEDY CO., Atlanta, Ga., has announced the formation of Davidson-Kennedy Associates. The new firm will act as an engineer-contractor and will carry out the design, procurement of equipment and materials, and erection of chemical process plants and facilities. President of the new firm is **Thornton Kennedy,** also president of Davidson-Kennedy Co. Offices will be in Chicago and Atlanta.

The new firm will be staffed by experienced engineering personnel. Heading the Chicago office are **James Iliff,** former Blaw-Knox Co., Chemical Plants division chief process engineer; and **Rex Wingard,** former Blaw-Knox Co., Midwest headquarters project engineer.

GEORGE E. FAILING CO., Enid, Okla., a subsidiary of Westinghouse Air Brake Co., held its annual sales meeting at the home plant in Enid. Attending the meeting were Walt Buller, sales manager; E. R. Lundberg, New York, export representative; Dick Miles, Houston branch manager; A. G. Floyd, Midland branch manager; John McMahan, Hattiesburg branch manager; Jack Felton; Jimmy Helton, manager Canadian operations; Robert M. Greer, president; Olaf Lindqvist, European representative; E. L. Alexander, senior vice president; E. L. Martin, Casper branch manager; and Arthur Johndrow, vice president sales.

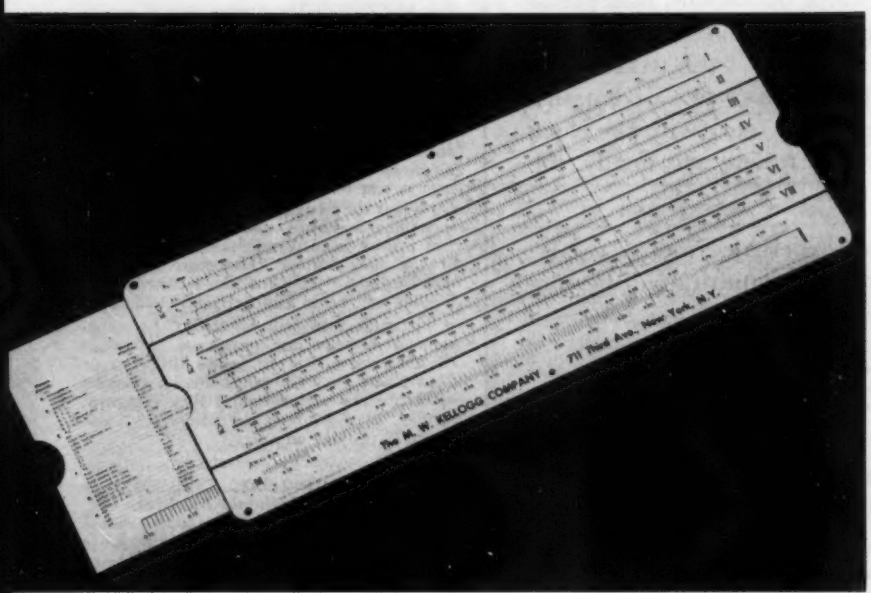
Also Kenneth Scheurmann, Oliver Kucera, Charles Wilson, Max Cumpston, Herschel Bules, Clarence Wheeler, Willard Britton, Bill Freeman, Ed Herbst, Clyde Baker, Burt Pedigo, Harold Holden, Russell Cowherd, Claude Chambers, H. J. Godschalk, Harold Allen, Calvin Cook, Bill Hall, Paul Nagle, Bill Ball, Bill Hiddleston, Joe Tracy, Everett Carley, Wesley Page, Carl Collins, Julian Stetnish, V. C. Mickle, Leon Christensen.

FOOD MACHINERY AND CHEMICAL CORP.'S recently formed FMC Organic Chemicals division has named **Dr. Desmond M. C. Reilly** manager. He will be responsible for the preparation of technical literature on the organic chemicals, plastics, plasticizers and pharmaceutical intermediates, made by the division, and also for the division's advertising program.

For the past four years, Reilly has been responsible for technical and promotional literature for the Westvaco Mineral Products and Westvaco Chlor-Alkali divisions of Food Machinery and Chemical. In addition since 1955 he has been sales promotion and publicity manager for the overall group of FMC chemical divisions. He received his Ph.D. degree in chemistry from the National University of Ireland in 1945, and subsequently taught at Notre Dame University, Ind., and Creighton University, Nebraska.

What's New in Equipment . . .

. . . and Manufacturers Literature



This New Slide Rule Helps You Make Fast Accurate Equilibrium Flash Calculations

A new Equilibrium-Flash slide rule, just developed, now enables engineers to make flash, bubble point and dew point calculations in less time than is required for present mathematical procedures. The slide rule is based on a newly developed method which converges toward the final solution more rapidly than the conventional calculation routine. This new slide rule makes it possible to cover in a simple way a wide range of percent vapor and equilibrium constant values without losing accuracy.

Calculations may be started with any arbitrarily assumed value of the percent vaporization using the slide rule. Succeeding equilibrium flash trials can then be quickly made until the final solution is reached. The essence of the method is that trial values to be assumed are automatically derived from the discrepancies found as results of preceding trials.

The new method was developed through a constant review of mathematical tools used in process and design engineering. The conventional half-graphical method of flash calculation was found to be inadequate, therefore the new method was evolved which is exact to desired accuracy, capable of rapid performance and capable of indicating the direction of the next step.

Free to qualified engineers stating name and title on company letterhead. Attach to business reply card, last page this issue. The M. W. Kellogg Company.

Circle E1 green card, last page.

New Report Reveals Chemical Salvage Methods

"A Salvage Program for Oil Refineries" is the title of a new special service report just published.

The report points out that efficient new chemical salvage methods now make it economically practical to reclaim equipment once considered unsalvageable. Recently developed detergents remove rust, grease, and old paint in one simple soaking operation, requiring no brushing, scraping, or sandblasting. The new materials are non-acidic and safe on both equipment and personnel, and they have long solution life.

The report also discusses selection of the salvage tank and a proved procedure for preventing rust. Oakite Products, Inc.

Circle E2 green card, last page.

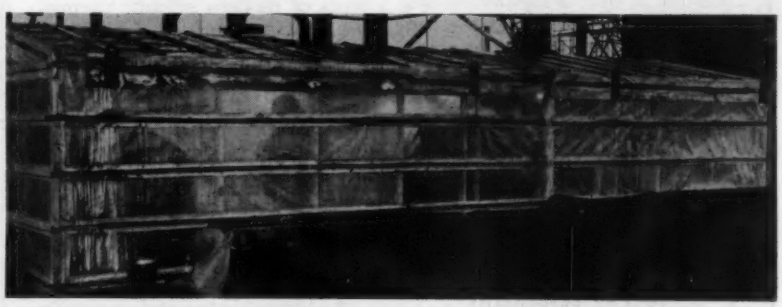
New Brochure Describes Silicone Fluid Applications

To aid designers in evaluating various silicone fluids for specific applications, a new reference brochure describing the physical and electrical characteristics of all leading silicone fluids now commercially available has been prepared.

Data in the new brochure are arranged in tabular form and include such standard properties as specific gravity, pour point, thermal conductivity, surface tension, refractive index, dissipation factor, and even specific heat.

Brief general descriptions of each fluid plus general application information are also provided. An excellent basic reference for every engineer's design file. Dow Corning Corporation.

Circle E3 green card, last page.



Polyethylene Film Protects Machinery Being Assembled

To protect machinery being assembled in the open from corrosive sea air at its new refinery, Tidewater Oil Co. has constructed an inexpensive type of all-weather shelter with film made of polyethylene. Tacked to knockdown wood frames, the tough film withstands rain, snow and winter winds and is inert to most chemicals. Construction is basically the same as for low-cost, polyethylene-film greenhouses which are now being erected throughout the country. The film is exceedingly light in weight and simple to install. Because the film is translucent, construction workers can assemble machinery in natural light. A large centrifugal blower may take several days to assemble, and, during this time, interior parts must be protected from moisture. Nine such blowers are being installed at the refinery. The flexible film

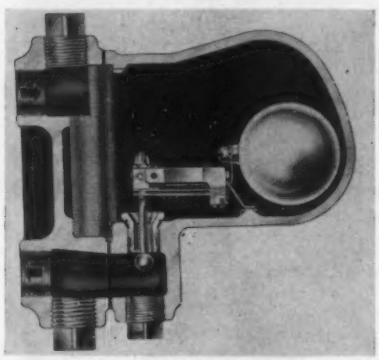
was tacked to the light wooden framework from rolls 20 feet wide and about 200 feet long. This film is highly resistant to tearing and it remains durable and flexible even at sub-freezing temperatures. Inside the temporary structure, air is kept warm and dry with infrared lamps. This not only makes it more comfortable for the workers assembling the machine, but also helps to prevent condensation of moisture which could cause corrosion of machine parts. Bakelite Co.

Circle E4 green card, last page.

Catalog Describes 11,130 Laboratory Glassware Items

A new 234 page technical glassware catalog contains current prices on 11,130 items of laboratory and scientific glassware. Special sections of the new edition are devoted to "Bantam-ware" small organic glass apparatus, tissue culture glassware, vacuum apparatus, "Forever Amber" volumetric ware and stopcocks for vacuum, pressure and routine applications. Illustrations, descriptive information and prices are close together to spotlight items for easy identification. Kontes Glass Co.

Circle E5 green card, last page.



New F & T Trap Has Only One Internal Valve

The mechanically operated group comprising float, float-thermostatic, open bucket and inverted bucket steam traps discharge condensate at steam temperatures. One particular trap from this group, the float-thermostatic trap has definite advantages against any other mechanical design because of its large air-venting capacity and continuous discharge features. This trap guarantees better and more efficient draining than intermittent operating bucket traps, especially where accurate temperature control is required. However, other float-thermostatic traps have two separate mechanisms, one operated by a bellows-thermostatic element to vent air, and the other by a float to discharge water. This trap has only one valve to perform both functions, and in addition, the same valve acts as a check valve. The results are reduced maintenance. It replaces 2 seats and valves found in standard F and T traps and 3 seats and valves in installations with check valves.

Exclusive features: Integral strainer, integral check valve, integral air venting (through the main valve), bi-metallic-stainless steel thermo-element (not affected by corrosion or fatigue), self-draining and freeze-proof, extremely easy in-line servicing, stellited stainless steel seat. Velan Valve Corporation.

Circle E6 green card, last page.

New Indicating Tape Changes Color to Reveal Acid Leaks

A plastic indicating tape for wrapping acid and caustic transport pipe lines has now been developed.

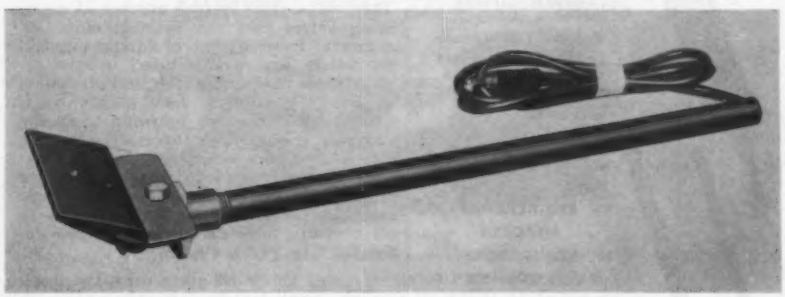
The plastic tape is wrapped around pipe lines and will indicate, by a discoloration of the tape, anywhere a leak or "weep" develops. Used primarily in areas where leaking acid or caustic would be a hazard due to passenger personnel, it is also being recommended for "hot" liquid transport area where leakage could damage equipment. In some cases it is being used to cover plastic piping systems which have been known to split due to vibration.

The tape is made of fiber glass with a vinyl covering and coated with a patented indicator. Acid lines are covered with a red colored indicator that turns yellow when triggered by leaking acid. A white colored tape is used for caustic lines and leakage of caustic liquid turns the color purple.

It is covered by a thin protective coating to prevent triggering by fumes or climatic conditions.

In a number of plants, both the tape and the indicating covers for valves and flanges are being used to afford maximum protection to personnel and equipment in dangerous areas. The valve and flange covers have the same indicating properties as the tape. They prevent acid or caustic spray and yet are provided with holes for drop leakage so that the corrosive liquids do not accumulate in the covers themselves. Within a matter of minutes after a leak occurs the indicator is triggered. Neirad Industries, Inc.

Circle E7 green card, last page.



Silicon Electrode Detects Holidays Without 'Wetting'

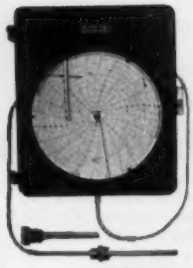
A new electrode for holiday detectors made of conductive silicon, which will not "wet" in hot coating material has just been developed. Used for inspecting flat coated surfaces by high voltage electrical energy, this conductive silicon electrode replaces the wire brush electrodes used for the past 25 years. The silicon, which looks and feels like black rubber, will wear indefinitely. It is moulded around a metal backing plate which has mounting holes for bolting the electrode to a wand.

Pipe coating materials such as hot bitumens, which clog wire brushes, will not adhere to this silicon due to its inherent non-wetting property. It will function equally well on dry or moisture damp surfaces. Its natural resistance to abrasion gives this electrode far longer life than wire brush electrodes which tend to frazzle and become tangled and matted. The rubber-like flexibility of the silicon material will conform to surface irregularities during the testing process and will readily indicate "holidays" in paint or di-electric

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating
Instruments



RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

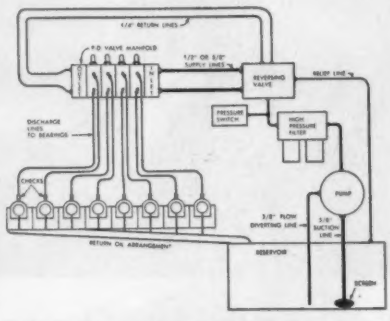
WRITE FOR CATALOG INFORMATION

PALMER
THERMOMETERS, INC.
Cincinnati 12 Ohio • MElrose 1500

New Equipment . . .

coatings on T's, valves, tanks, and structures. Closely approximating the conductivity of wire, this conductive silicon material gives testing efficiency equal to all other types of electrodes in general use. Tinker & Rasor.

Circle E8 green card, last page.



Lube System Warns of Clogged or Broken Lines

A new type of circulating oil system has been designed to serve the lubrication needs of presses, automatic and semi-automatic machine tools, etc. Lubrival employs the two-line principle of operation to supply oil under pressure to measuring valves for delivery to bearing points. The valves have individual sight indicators and feature the positive piston displacement method of feeding lubricant.

Lubrival monitors its own operation through a pressure sensing mechanism to warn of clogged or broken lines in any part of the system. Circulating oil systems heretofore have failed to provide indication of broken discharge lines.

For operating flexibility, a variable delivery pumping unit permits a wide range of selection in the number of injections per minute applied to bearing points. There is no limit to the number of measuring valves that can be manifolded together to serve a piece of equipment, and the valves are manufactured in two capacities for interchangeable installation as required. In addition, since each valve is designed to serve two bearings, a simple, external cross-porting accessory can be attached at any time to merge two discharge ports into one. Simplicity of design and soundness of operating principle ensure that temperature-induced changes in oil viscosity have no effect on valve deliveries. The Farval Corp.

Circle E9 green card, last page.

Stainless Pipe Available Now in Long Lengths

Two super corrosion-resistant stainless steels known as Carpenter Alloys B and C are now available for the first time in full finished long lengths of tubing and pipe.

Mill lengths of up to 20 feet 6 inches are now supplied for use anywhere that extra long lengths are required for process lines, heating coils and similar applications.

Alloy B is a nickel-molybdenum-iron alloy with unusually high resistance to hydrochloric acid in all concentrations and at all temperatures. It also has strong resistance to boiling sulphuric acid, phosphoric acid and wet hydrogen chloride gas. In handling any solution, it is effective only under non-oxidizing conditions.

Alloy C is a nickel-molybdenum-chromium-iron alloy with excellent resistance to aqueous solutions of halogen salts, nitric acid, and acid solutions of ferric and cupric salts. In addition, it is highly resistant to acetic, formic and sulphurous acids . . . and effectively withstands hydrochloric, and phosphoric acids.

Both grades can be produced to meet three general sections of ASME Code Cases 1173 and 1194 concerning, (a) chemical composition, (b) mechanical properties, and (c) fluid penetrant dye inspection of weld area.

All of this full finished tubing meets the high quality requirements for heat exchanger applications. Sizes available include ⅜-inch to 4½-inch O.D. in tubing, and ¼-inch to 4 inch in pipe.

Both alloys are made from Hastelloy strip. Carpenter Steel Co.

Circle E10 green card, last page.

Flexible Fixture Support For Hazardous Locations

A flexible fixture support for use in hazardous locations on pendant type explosion-proof fixtures has been designed.

The fixture is available in a wide variety of sizes and styles. It has been approved for Class I, Group C and D, Class II, Group E, F and G. Killark Electric Co.

Circle E11 green card, last page.

Spectrochemical Analysis Described in New Brochure

An informative, new 28-page illustrated brochure describing the basic fundamentals of spectrochemical analysis, and including a bibliography of reference material of value to spectrochemical analysis is available.

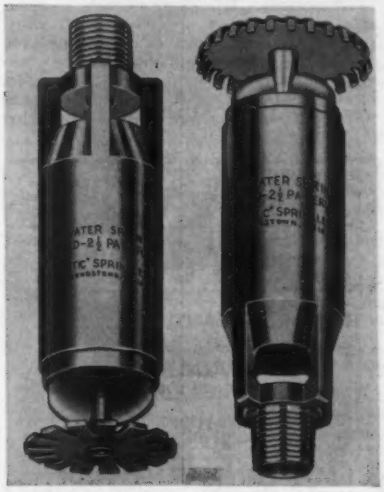
Written in easily understood language, this comprehensive booklet outlines with interesting detail the methods, instruments and accessories encountered in all phases of spectrochemical analysis and includes examples of typical analytical problems,

New Equipment . . .

suggested laboratory floor plans, plus information on special purpose instruments.

This brochure represents the first of a series of spectrochemical reference handbooks currently being prepared.
Jarrell-Ash Co.

Circle E12 green card, last page.



Upright or Pendent Heads For Foam-Water Sprinklers

New designs for both an upright and pendent sprinkler head for use in combination airfoam and water spray fire protection systems have just been announced. The pendent sprinkler head, never before available for this use, permits adaptation of water sprinkler systems to the combination use in special hazard situations without re-piping, even where space is limited between present piping and ceiling.

In use, it first discharges a large volume of thick foam to blanket "spill" or surface fires, then produces a water spray. A predetermined quantity of foam producing material automatically introduced into the system produces the foam blanket before the regular water spray issues from the same head or nozzle. More economical than a continuous foam discharge, the water spray also provides additional protection to surrounding surfaces from "torch" fires at broken chemical or fuel lines.

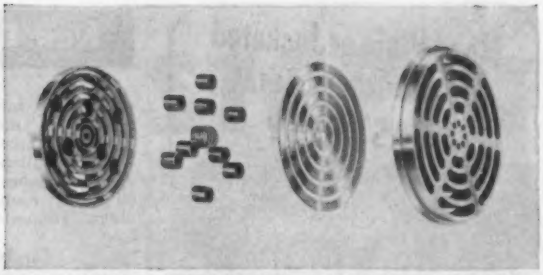
The additional safety factor offered by the water spray does not diminish the protection established by the foam blanket, which maintains its effective fire-smothering consistency for approximately one-half hour under the water deluge. Manual controls on the system permit change to the water spray at any time during the foam discharge and also permit the laying of a blanket of foam as a fire preventive at any time, without the shower of water. Automatic Sprinkler Corp. of America.

Circle E13 green card, last page.

Reference Book On Plug Valves Available

A new 28 page reference book is available to engineers and those persons interested in design operations and maintenance of plug valves. This book contains

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

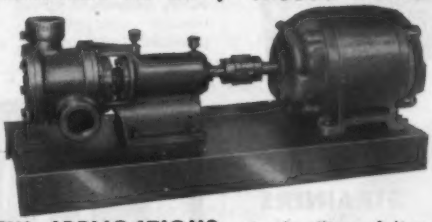
J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

handle those *difficult jobs*

with

AURORA® APCO *Process* PUMPS



NEW APPLICATIONS — the handling of liquefied petroleum gases, refrigerants and other light non-viscous liquids are easy for APCO Z4 Pumps.

SPECIAL METALS — APCO Z4 Pumps are obtainable in any machineable alloy. The small amount required of such metal represents a real economy.

PERFORMANCE FEATURES — of the APCO Pump are ideal for the type of process duties for which the APCO Z4 Pumps were designed.

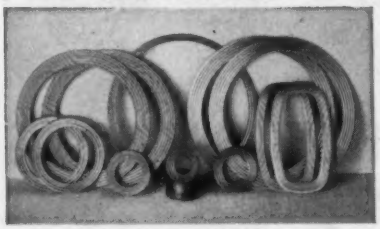
Write for BULLETIN 111-ZA

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
84 LOUCKS STREET • AURORA • ILLINOIS
EXPORT DEPARTMENT — Aurora, Illinois — Cable Address "NYABINT"

For more data on advertised products, use Readers' Service Cards, last page.

Need Plain or Jacketed CORRUGATED METAL GASKETS?



Call CHICAGO-WILCOX for PROMPT ATTENTION

Chicago-Wilcox understands the gasket requirements of refineries and is equipped to supply all types of gaskets, including plain or jacketed corrugated metal gaskets like these. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel, and monel in all sizes and shapes.

Send specifications for quotations and prompt-delivery schedule.

CHICAGO-WILCOX MFG. CO.
7703 Avalon Avenue, Chicago 19, Ill.
Phone: SAginaw 1-1900

YOU'LL FIND IT HERE!

BLINDS
SPACER RINGS
STRAINERS
FLANGES

Our eight pages in the 1957 Refinery Catalog present a complete picture —Descriptions—Specifications—Data.

You'll like the scope and quality of our products and service. The equipment you need available from stock or made to your exact requirements.

See our pages in Refinery Catalog or write direct for Mac-Iron Catalog A-7. Your request will receive immediate attention.

SANDUSKY MAC-IRON OHIO
ESTAB. 1901

The Mack Iron Works Company
Warren and Water Sts. - Sandusky, Ohio

New Equipment . . .

engineering information such as principal dimensions, metals of construction, and types of control. It covers lubricated plug valves in full port and venturi types, sizes up to 20 inches, with a choice of rectangular port, round port or diamond port plugs. Homestead Valve Manufacturing Co.

Circle E14 green card, last page.

Part-Winding Starter Reduces KVA Inrush

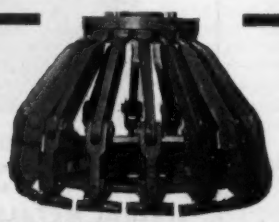
A new method of one-step increment starting for induction motors, which provides reduced light flicker and quieter motor operation during acceleration, has been developed.

Major application of the new starting method is expected to be in large commercial buildings and other locations where power companies require large induction motors be started with reduced KVA inrush. Typical uses are air conditioning compressors, refrigeration compressors, fans, pumps, and blowers.

The new system, called a two-thirds part-winding starter, will accelerate most loads to full speed on the part winding. This eliminates the second increment of current inrush characteristic of conventional part winding starting.

The starter is easily connected for conventional one-half part-winding starting as well as the new two-thirds part-winding starting. Simple reconnection of the leads of a standard 208-220/440-volt motor to the new control is the sole operation necessary for either type of start, according to company engineers.

Designated CR7050, the starter is available in ratings up to 400-hp, 600 volts. Its 4-2 pole arrangement makes possible one of the most economical reduced-current starter-motor combinations available. It consists of two contactors and a pneumatic time-delay contact. One contactor



BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

STEEL PIPE and TUBING

- CARBON MOLY
- CHROME MOLY
- STAINLESS
- CARBON

ALL SPECIFICATIONS – ANY SIZE
Write for Stock List

MIDCONTINENT TUBE SERVICE, Inc.
2308 Oakton St., Evanston, Ill., Davis 8-4030

SCHOTCO
WAX PRESS FILTER BLANKETS

- Made only of first grade hydraulic press 12/0 duck
- Fabricated to your specifications
- Priced to save you money
- Cupraammonium treated

Write today for the Schotco story

SCHOTT BROS. CO. INC.
WEST SALEM, OHIO

GUNITE
Since 1915
CONCRETE
SAND AND CEMENT
"Placed by Air"

We have the equipment, personnel and experience to complete any and all GUNITE work regardless of size or location.

Send for specifications and bulletins

GUNITE CONCRETE & CONST. CO.
1301 WOODSWETHER RD., KANSAS CITY 5, MO.
2016 WEST WALNUT, CHICAGO 12, ILLINOIS
3206 HOUSTON, HOUSTON 9, TEXAS
1508 PARKWAY DRIVE, ST. LOUIS 4, MO.
Milwaukee and Twin Cities—Denver—New Orleans

this NO-COST TEST OFFER
has CONVINCED thousands
. . . send for YOUR FREE
"TEST CAN" of C-5 "hi-temp"
ANTI-SEIZE THREAD COMPOUND!

For chemical plant uses, on all studs and bolts exposed to temperatures up to 1800°F. such as on compressor head assemblies, hot pump studs, autoclaves, reactor flange studs, heaters, heat exchangers, "cat" crackers, stainless steel assembly.

Try C-5 and see why leading refineries, manufacturers and power producers have made it part of their regular preventative maintenance program.

fel-pro C5 "HIGH-TEMP"

- ✓ Ends Seizing and Galling even up to 1800°F.
- ✓ Reduces Wrench Torque
- ✓ Ends Stud Breakage
- ✓ Permits Repeated Re-use
- ✓ Speeds Assembly and Disassembly
- ✓ Protects Stainless Steel at all Temperatures

1614-C

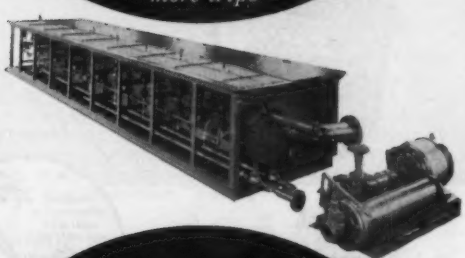
ANTI-SEIZE THREAD COMPOUND

C-5's exclusive colloidal copper formula separates mating metal threads and surfaces with cushioning, protective copper plating. C-5 prevents galvanic action and eliminates pitting even when dissimilar metals join. On mating metal surfaces, C-5 saves gaskets and countless man hours.

WRITE TODAY . . . For Your FREE Test Sample Can of C-5.

FELT PRODUCTS MFG. CO.
1546 Carroll Ave., Chicago 7, Illinois

gilco
DRUM
RECONDITIONING MACHINES
keep your drums making more trips

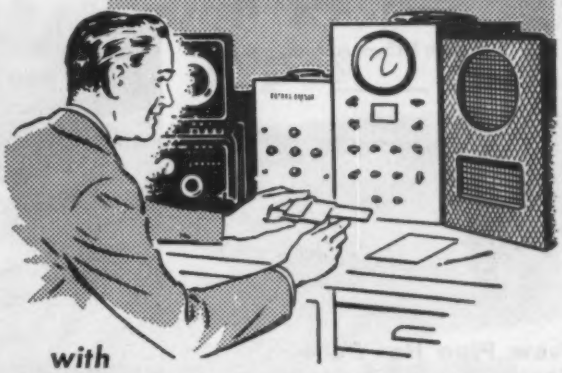


Model RNF-56, GILCO Drum Flusher for internally washing steel drums can be constructed so wash and rinse can be performed on same nozzle. Nozzles oscillate 360° and are off-set from hot solution tank. Available for two to ten drum stations.

There's a GILCO machine for every phase of steel drum reconditioning. For complete details and specifications on the equipment to solve your particular problem, write, DEPT. FW. .

L. M. GILBERT COMPANY
1505 Race Street, Philadelphia 2, Pa. Cable: LMGILCO

STOP
EXHAUST NOISE and PIPING VIBRATION



with
BURGESS-MANNING SNUBBERS

Burgess-Manning engineers have spent years of scientific research into the cause and nature of exhaust noise and pipe line vibration. Out of this research came the Burgess-Manning Snubbing Principle.

Throughout the world, Burgess-Manning Snubbers, utilizing this unique principle, are eliminating the deafening, efficiency-reducing roar of engine exhaust and the destructive effects of pipe system vibration and pulsation where compressible gases are pumped.

Engineered by specialists for the specific applications, Burgess-Manning Snubbers pay for themselves in increased efficiency of equipment and personnel, lowered maintenance costs, improved labor and neighborhood relations.

This engineering service, with years of experience in the elimination of noise and vibration, is available for consultation on your problem without obligation.

Write for copies of case histories of typical installations.

Present your problems for Analysis and Recommendations

BURGESS-MANNING COMPANY
Sound Engineering
711 East Park Avenue, Libertyville, Illinois
Dallas, Texas

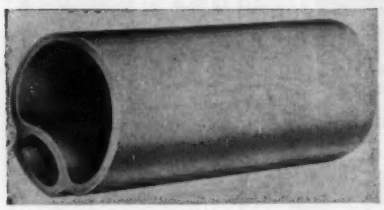
For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

has four poles and the other two poles, each contactor selected for half the horsepower rating involved. The time-delay contact, located on the 4-pole contactor, provides the time-delay interval from "start" to "run."

Smooth acceleration and reduced motor heating are other advantages of the new starter. Average line current is about the same as for one-half winding starting. The enclosed forms have ample wiring space and all wiring is front connected. General Electric Co.

Circle E15 green card, last page.



New Pipe Has Built-In Steam Tracer System

Lower cost and higher efficiency of steam-traced piping now is possible with a new design in Unitrace, the company's unique method of heating product pipe lines.

When introduced in 1953 as the first extruded aluminum pipe with an integral steam passage, Unitrace was oval in shape. The sales development division engineers recently designed the one-piece, steam-traced piping with a cross-section matching standard pipe sizes. It is available in nominal sizes of 1½-inch, 2-inch, 3-inch and 4-inch.

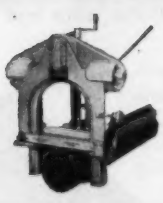
Immediate advantages to steam-traced piping users are lower cost per foot, and easier, faster installation. In use, the new design boosts efficiency by increasing the transfer of heat internally, and cutting heat-loss of external radiation. These characteristics, combined with the natural corrosion-resistance of aluminum, make this pipe ideal for a wide range of products that must be handled by steam-traced piping. Aluminum Co. of America.

Circle E16 green card, last page.

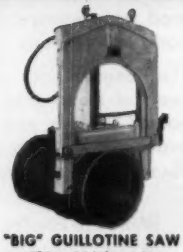
Insulation Blocks

Workmen are shown applying the finishing touches to an insulation job on a 40,000 barrel butane storage spheroid. The lightweight blocks are impaled on studs tack-welded to the steel plates of the vessels. Imbedded, sealed, and covered with an asphalt cut-back, the Foamglas helps to maintain a 50 F temperature in the tank to keep the volatile butane in a liquid

WACHS *Portable*
POWER AND MANUAL PIPE CUTTERS
2" TO 72" CAPACITY



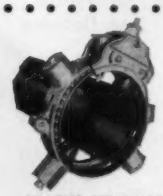
WACHS GUILLOTINE SAW
2" to 8" Capacity
Electric or Air Drive



"BIG" GUILLOTINE SAW
10" to 16" Capacity

WACHS CHICAGO

WACHS NATIONAL SAW
"The milling machine on wheels"
Cuts 10" to 72" Pipe



WACHS STRICKLER RATCHET CUTTER
"Lathe Type Cuts"
5 sizes—2½" to 24" Capacity

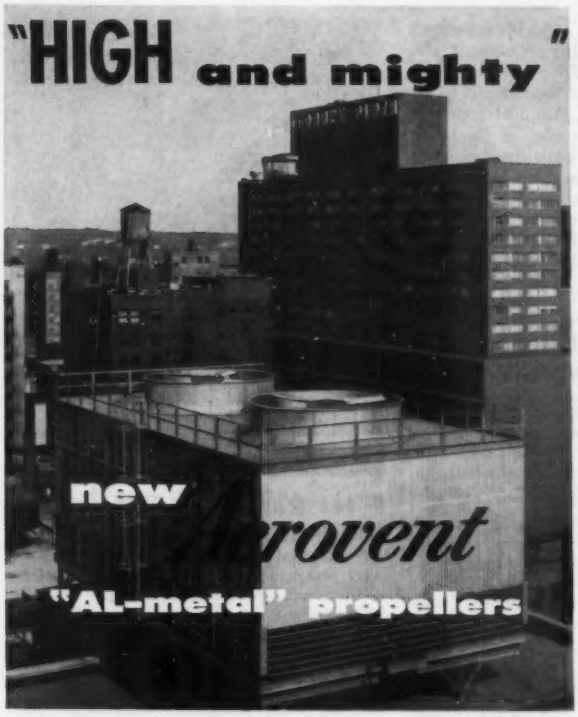
Write for descriptive bulletins

THE E. H. WACHS COMPANY
1525 NORTH DAYTON STREET · CHICAGO 22, ILLINOIS

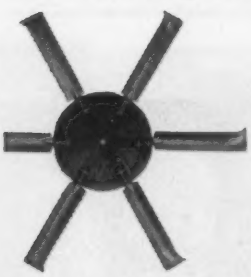
PROBE into your pH problems on-the-spot
with the Analytical pocket pH meter

Analytical Measurements, Inc.
585 Main St., Chatham, N. J.
Instrument size: 3 x 5⅛ x 2½ inches
Case size: 3¾ x 6½ x 4¼ inches
Weight with accessories: 3 lbs.
$125.

Analytical Measurements, Inc.
585 Main Street, Chatham, N. J.
Please send full information about your pocket pH meter to:
Name _____
Company _____
Address _____
City _____ State _____



move mountains - of AIR!
in towers and exchangers



- Sizes 14′ to 18′
- 4 or 6 blades

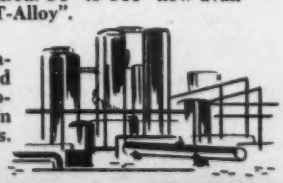
Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

Write for free Bulletin 510

DESIGNED FOR DEPENDABLE OPERATION!

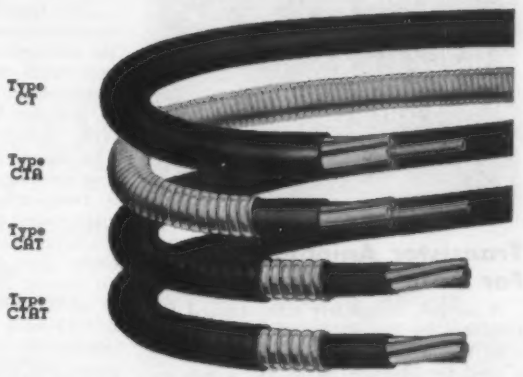
Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in revolutionary new "T-Alloy".

REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



Aerovent FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg.
TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO

CRESCENT ARMORED MULTITUBE
In Four Corrosion Resistant Types



For Pneumatic and Hydraulic Instruments and Control

TYPE CT—For damp or corrosive locations where a moderate degree of mechanical protection to the tube is required. It employs a corrosion-resistant thermoplastic sheath, resistant to water, acids, alkalies, oil, and is flame-retardant.

TYPE CTA—Where maximum mechanical protection is desired during and after installation, such as direct burial in wet concrete and for pulling into conduit.

TYPE CAT—For maximum protection against corrosion and mechanical injury to the tubing.

TYPE CTAT—Combining the advantages of Types CTA and CAT, the fourth type illustrated has the polyvinyl chloride thermoplastic sheath both under the armor and over the armor, thus providing maximum mechanical and corrosion protection.

CRESCENT ARMORED MULTITUBE* consists of long-length tubes twisted together to permit bending without distortion. In each layer, one tube is a bright blue color, affording a fast means of identification from both ends.

Available in long runs from 2 to 19 tubes of copper, aluminum and polyethylene tubing in sizes ¼" O.D. This product is licensed under U. S. Patent No. 2,578,280.

* Reg. Trade Mark

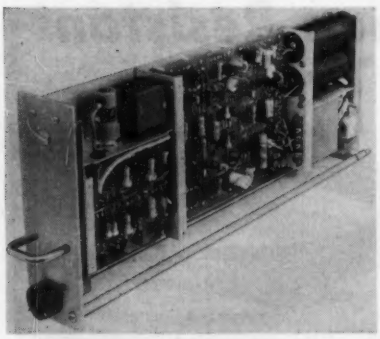
Send for Bulletin No. 356-G

CRESCENT
INSULATED WIRE & CABLE CO.
TRENTON, N. J.

New Equipment . . .

state. The closed cell structure of glass insulation, when used in conjunction with suitable mastic and reinforcing membrane, serves as an effective barrier to moisture penetration. Pittsburgh Corning Corp.

Circle E17 green card, last page.



Transistor Amplifier For Data Handling

A unique, completely transistorized DC amplifier for use in situations where the need for high accuracy is combined with a need for absolute reliability, is now offered.

The Model WN, a general-purpose, chopper-stabilized unit, was designed to meet the high reliability standards demanded by chemical and petroleum companies for data handling equipment to be used in process-control. Amplifiers similar to the Model WN are used in Beckman 112 Systems now being built for a number of companies in the process industries.

The Model WN is actually a package of four separate amplifiers, each contributing to the precise amplification of the input signal. Two of these act as power supplies, producing an accurate plus or minus 25-volt potential. The power transformer in these units is completely isolated from earth ground, allowing the entire Model WN package to "float" relative to ground.

The signal itself passes through two amplifiers, one an AC unit that amplifies the chopped signal, the second a DC unit that takes the signal after it has been demodulated and filtered. A plug-in "can" of precision resistors permits rapid, foolproof change in net amplification ratio. The elimination of vacuum tubes in all four amplifiers means that the Model WN is completely free of microphonics, no matter what the service conditions.

Characteristics of the Model WN include: 2uv drift in 24 hours at 25 C; .01 percent linearity at DC; noise referred to input is only 3uv p-p at 0-1 cps; output is ± 15 volts at 100 milliamperes; output impedance is .02 ohms. Power requirements are 105-125 volts, 60 cycle current. Beckman Instruments, Inc.

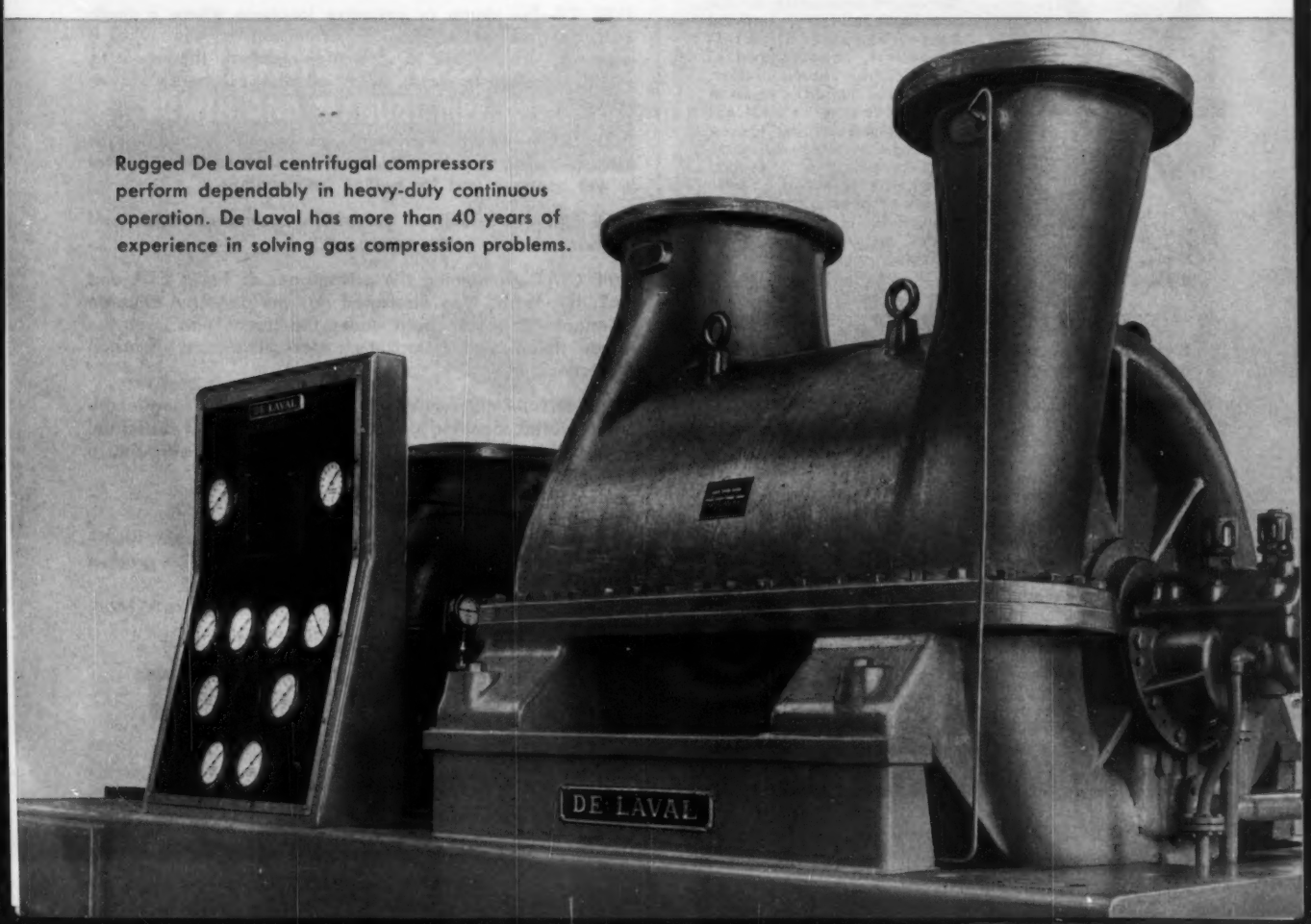
Circle E18 green card, last page.

Filter Retaining Screen For Sulfuric Acid Plant

This giant filter media retaining screen was recently completed for an eastern sulfuric acid producer. The unit was the largest single set of wire cloth fabrications ever built by the company. It consists of 2 cylindrical screens, one fitting into the other in the final installation. The outer cylinder is 20 feet high by 13 feet in diameter, while the inner unit is 20 feet high with a 10-foot diameter. Both were produced in four sections each, from 3 x 3 mesh of .135 stainless steel wire cloth of double crimp weave. The Cambridge Wire Cloth Co.

Circle E19 green card, last page.

Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.



New Equipment . . .

Some New Vapor Filters For Large Pipe Sizes

A new line of gas and air filters for 6-inch, 8-inch and larger pipe sizes has just been announced.

The filters are equipped with a patented built-in baffle that assures maximum passage of gases and air through the filtering material and gives complete removal of dust and scale.

The filters are reversible end-for-end and top-for-bottom to eliminate the possibility of improper installation in the field. Norwalk Valve Co.

Circle E20 green card, last page.

Safety Wall Chart on Caustic Soda Handling

A new safety wall chart on caustic soda is now being offered.

This chart, written in nontechnical language, includes suggestions for protective clothing and equipment; rules and precautions to be followed in the unloading, handling and storage of caustic soda; first aid measures to be followed in the event of an accident; and instructions for safely thawing caustic soda in tank cars. Allied Chemical & Dye Corp.

Circle E21 green card, last page.

Mechanical Seal Catalog Shows Operating Conditions

Designers, manufacturers and operators of processing equipment will find it easy to select the right type of mechanical seal to meet a specific operating condition by referring to this new catalog on rotary mechanical seals.

The catalog is extensively illustrated with cutaway views showing stuffing box installation details. Each seal is attended by a quick reference covering the temperatures, pressures and fluids it is designed to serve. Durametallic Corp.

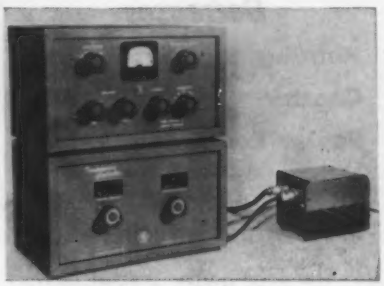
Circle E22 green card, last page.

New Technical Paper Covers Asphalt Additives

A technical paper prepared by chemists in a research department has proved of interest for many asphalt applications.

"The Function and Chemistry of Asphalt Additives" is a technical paper providing asphalt coating application engineers and chemists with data on ionic surface active agents. It explains the function of increasing the wetting and bonding properties of asphalt and asphaltic compounds. It provides information on the chemical properties of surface active agents necessary for chemical stability in asphalt at the highest temperatures asphalt is used. Carlisle Chemical Works, Inc.

Circle E23 green card, last page.



New Cell Increases Chromatography Range

The effective operating range of Chromatographic analyses can now be appreciably extended through the use of a new high temperature thermal conductivity cell just developed. Designated Model 75, this new cell is designed to operate over

DE LAVAL
CENTRIFUGAL
COMPRESSOR

helps boost cat-cracker capacity at Shell Oil of Canada, Limited

To obtain extra capacity, the Montreal East refinery of the Shell Oil Company of Canada, Limited decided to rebuild its cat-cracker. Since the modernized cracking unit required a greater volume of air, Shell of Canada selected a dependable De Laval centrifugal compressor handling 16,400 cfm.

This compressor operates at an inlet pressure of 14.3 psia and a discharge pressure of 42.8 psia. The power required is 1860 bhp with the compressor operating at 5400 rpm.

The Shell Oil Company of Canada, Limited is another refinery which has chosen De Laval compressors for heavy-duty continuous service. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval.

Send for Bulletin 0504

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

811 Nottingham Way, Trenton 2, New Jersey

DL-578

New BRACKET AND LINKAGE for Butterfly Valves

Increases

Operator's Rangeability

Stability of Control

Reproduceability

Decreases

Hunting

Chatter • Friction

Power Requirement

Enables

Easier Field Adjustment

Standard parts — prompt delivery — maximum flexibility of application make mounting of operator at point of valve installation quick and easy. Made for valves to 48" size.

W. S. ROCKWELL COMPANY — 2367 Eliot Street, Fairfield, Connecticut

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

safe

simple

sure

HIGH-PRESSURE NEEDLE VALVES

Forged steel valves in ¼" – ⅜" – ½" or ¾" sizes for high-pressure throttling gauging or sampling services. The safety bonnet type meets exacting safety requirements.

Available in 416 Stainless Steel – other alloys to special order.

ENGINEERS . . . write for illustrated Bulletin 101.

SPINDLER VALVES and other specialties since 1894

August Spindler & Sons, Inc.

Mercer Street, Jersey City 2, New Jersey

New Equipment . . .

a range of 30 C to 325 C, and will accommodate liquids with boiling points up to 475 C. This is virtually at the upper operating limit of chromatography, as beyond this point organic molecules begin to break down. The cell may be incorporated into any existing chromatographic apparatus.

Exceptional stability and sensitivity is achieved for the first time at these high temperatures by use of flake thermistors as the sensing elements. They have been developed to the point where they are completely rugged, dependable sensing elements and widely used in various types of military equipment.

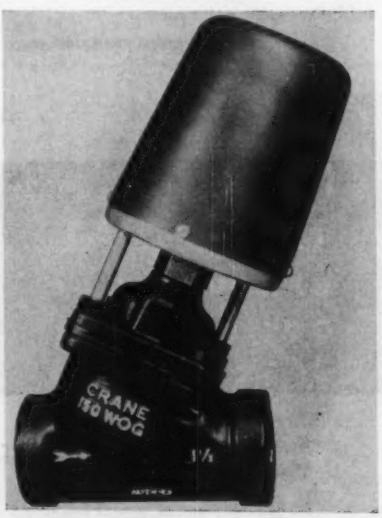
Model 75 Thermal Conductivity Cell consists of 3 separate units:

1) The detector proper enclosed in a specially designed oven, designed for minimum drift at maximum sensitivity. Stainless steel construction is used to eliminate danger of corrosion and contamination.

2) The temperature controller, continuously variable from 30 C to 350 C. Proportional control assures accurate temperature monitoring, freedom from variations in ambient temperature, and independence of fluctuations in line voltage.

3) The bridge circuit, and power supply—a specially designed wheatstone bridge for use with flake thermistors. Barnes Engineering Company.

Circle E24 green card, last page.



Valve Controller Mounts Directly on Valve Stem

A new all-electric rotary valve controller designed for mounting on the valve stem is now announced. The Valvetrol provides remote or automatic valve operation with proportional or on-off control.

The Valvetrol is a self contained gear motor with hollow output shaft that receives the valve stem. Stem diameters from on-fourth to one-inch can be accommodated. When used on rising stem valves the adaptor "swallows" the stem. The Valvetrol incorporates a built-in potentiometer which may provide remote indication of valve position or which may be used as a part of a balanced bridge control. Typical of the latter is its use in automatic proportioning systems where the valve setting must be proportioned to

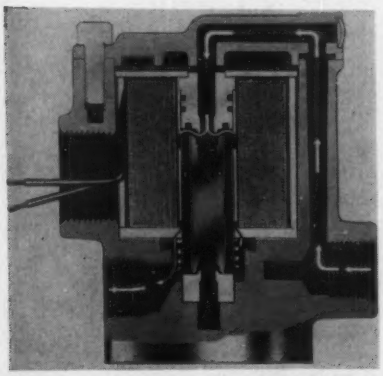
For more data on advertised products, use Readers' Service Cards, last page.

a signal that may originate from liquid level, flow-rate, pressure or other source. Valvetrols can be furnished to provide follow-up accuracies of plus or minus 1/25 of 1 percent. Standard low cost Valvetrols provide accuracies of 1/5 of 1 percent.

Valvetrols are designed to mount on the valves of all leading manufacturers. The photograph shows a Valvetrol mounted on a Crane 1½-inch diaphram valve. Note that it is mounted on the valve stem and that the torque rods are extensions of the studs holding the valve bonnet to the body. It is mounted with a hex stock adaptor so that the valve can be turned by wrench in the event of power failure.

Permanent split capacitor or three phase Valvetrols may be had in totally enclosed or explosion proof constructions. The Valvetrol can be furnished mounted on the valve or separte for mounting on valves in the field. The Jordon Co., Inc.

Circle E25 green card, last page.



Solenoid Pilots Designed For Internal Cooling

Continuous internal cooling of the solenoid coil and self-cleaning effect of the actuating plunger prevents overheating and assures multi-million cycle trouble-free service life of solenoid pilots, according to an announcement by the company.

The operating medium, carrying entrained lubricant, passes through the center of the solenoid, between the plunger tube and the plunger. This provides internal cooling, as well as continuous lubrication of the plunger, to assure free movement throughout the life of the solenoid pilot. The coil is completely sealed from the operating medium by multiple Hy-car seals. Encased in molded epoxy resin, the coil is guaranteed against burn-out for the life of the valve.

Normal leak-free service life in excess of 25 million cycles is said to be attained through the use of stainless steel seats, plunger and plunger spring. The plunger and spring are the only moving parts.

The solenoid pilots, capable of handling air, vacuum, oil, water and inert gasses, for direct, sub-base or manifold mounting, are available in 2 and 3-way types for separate pilot control applications. Solenoid coils are supplied for 3 to 300 volts dc and 6 to 550 volts ac, 25 to 60 cycles. Coil current consumption, at 115 volts, 60 cycles, is .2 amps. Valvair Corp.

Circle E26 green card, last page.

Advertisers in This Issue

PETROLEUM REFINER, May, 1957

* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1957 Refinery Catalog.

A

Aerovent Fan Company
Large Propeller Division 409a
*Air Products, Inc. 296
*Airetool Manufacturing Co. 391
Allied Chemical & Dye Corp. 51, 89
*Allis-Chalmers Mfg. Co. 35, 36
*Aluminum Company of America 277, 342
Amercoat Corp. 107
American Air Liquide 12
American Aniline Products
Division Koppers Co. 379
*American Brass Co. 106
American Cast Iron Pipe Co. 34
*American Chain & Cable Co. 148
American Cyanamid Co.
Refinery Chemicals Dept. 116
*American Machine & Metals, Inc. 372
American Petroleum Institute 317
*American Recording Chart Co. 340
American Steel & Wire Division
United States Steel Corp. 313
Analytical Measurements, Inc. 408a
Arcos Corp. 388
Armco Steel Corp. 144
Armstrong Cork Co. 31
Armstrong Machine Works 32
The Atlantic Refining Co. 125
Atlas Powder Co. 143
*Aurora Pump Division
The New York Air Brake Co. 405b
Avondale Marine Ways, Inc. 345b

Fume Ducts in Large Sizes Are Corrosion Resistant

As part of the complete line of corrosion resistant polyester glass fume ducts now being produced, these 15 inch diameter ducts are molded into a single piece. Glass smooth inside and out, they claim to provide high resistance to chemical corrosion of acids, hypochloride salts, weak alkalies, and many organic solvents. The line has recently been expanded to include standard sizes to 24 inches in both rectangular and circular ducts. Special sizes and shapes are being produced to customer's specifications. Haveg Industries, Inc.

Circle E27 green card, last page.

B

*B-I-F Industries, Inc. 2
*The Babcock & Wilcox Co. 81
*Badger Manufacturing Co. 132
Baker & Co. 128
*Barco Manufacturing Co. 292
Barrett Manufacturing Co. 406c
Belmont Packing & Rubber Co. 351
Bethlehem Steel Co. 53
Betz Laboratories, Inc. 286
*Bigelow-Liptak Corp. 80
Bingham Pump Co. 90-91
The Bird-Archer Co. 294
*Black, Sivalls & Bryson, Inc. 354
*Blaw-Knox Co. 22, 68, 375
Bonney Forge & Tool Works 368
Bopp & Reuther G. m. b. H. 102Ca
*Borden Metal Products Co. 337
*Borg-Warner Corp. 94, 133
*Botfield Refractories 381
*Bridgeport Brass Co. 30
The Bristol Co. 69, 70
British Ermeto Corporation Ltd. 102Da
Bucyrus-Erie Co. 37
*Buell Engineering Co. 162
*Buffalo-Eclipse Corp. 100
Burgess-Manning Co. 407c
*Byron Jackson Pumps, Inc.
Division Borg-Warner Corp. 94

C

*Calumet & Hecla, Inc. 331, 332
*Camco Products, Inc. 367
*The Cape Asbestos Company Ltd. 109
*G. O. Carlson, Inc. 60
*The Carpenter Steel Co. 127
Carter-Waters Corp. 398d
Catalytic Construction Co. 397
*Catawissa Valve & Fittings Co. 346
The Chapman Valve Mfg. Co. 84
Chase Brass & Copper Co. 23
*Chemical Construction Corp. 153
Chicago Metallizing Co. 285
*Chicago-Wilcox Mfg. Co. 406a
*Chiksan Co. 113
Cities Service Co. 366
*Clark Bros. Co. 310-311
Classified Advertising 400
Columbia-Geneva Steel Division
United States Steel Corp. 96, 313, 347
Commercial Solvents Corp. 105
Conoflow Corp. 21
Consolidated Electrodynamics Corp. 120
*The Cooper-Bessemer Corp. 98-99
*Coppus Engineering Corp. 121
*Corning Glass Works 288
Cosasco Division
Perfect Circle Corp. 377
Crane Co. 273
Crane Packing Co. 279
Crescent Insulated Wire & Cable Co. 409b
Crouse-Hinds Co. 63

D

Davison Chemical Company
Division W. R. Grace & Co. 140-141, 359
De Laval Steam Turbine Co. 410-411
Dicalite Division
Great Lakes Carbon Corp. 382
*Dollinger Corp. 86
*Dorr-Oliver, Inc. 88
Dowell Incorporated 161
*Downingtown Iron Works, Inc. 393
*Dresser Industries, Inc. 310-311
*The Ducon Co. 370
E. I. du Pont de Nemours & Co. 49, 135, 136, 168
The Duriron Co. 348

Continued on Page 414

Advertisers in This Issue

Continued from Page 413

PETROLEUM REFINER, May, 1957

*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1957 Refinery Catalog.

E

The Eagle-Picher Co. 92
*Eastern Industries, Inc. 380
Eastman Chemical Products, Inc. 76
Electric Steel Foundry Co. 28
*Elliott Co. 302-303
Enjay Co. 59
Esso Research & Engineering Co. 315
Ethyl Corp. 170-171

F

Felt Products Mfg. Co. 407a
*Fibreboard Paper Products Corp. 355
Fischer & Porter Co. 62
Fisher & Ludlow Limited 104
*Fisher Governor Co. 278
Flexonics Corp. 396
The Flori Pipe Co. 78
The Fluor Corp. 159
The Foram Corp. 345a
Benjamin Foster Co. 378
*Foster Wheler Corp. 18-19
The Foxboro Co. 82-83
Frick Co. 398a

G

*The Garlock Packing Co. 126
Gas Atmospheres, Inc. 137
General Chemical Division
Allied Chemical & Dye Corp. 89
L. M. Gilbert Co. 407b
The Girdler Co. 24
The Globe Co. 363
Claud S. Gordon Co. 284
W. R. Grace & Co. 359
*Graham Manufacturing Co. 384
*Graver Tank & Mfg. Co. 6
Great Lakes Carbon Corp. 382
A. P. Green Fire Brick Co. 55
*Grinnell Co. 110
*The Griscom-Russell Co. 297, 298
Gulf Publishing Co. 401
Gunite Concrete & Const. Co. 406f
Gutehoffnungshuette 345a

H

*Hammond Iron Works 72
The Harshaw Chemical Co. 124
Hartsell Propeller Fan Co. 358
Wyatt C. Hedrick Engineering Corp. 156
*Hendrick Manufacturing Co. 361a
Hercules Powder Co. 111
*Hetherington & Berner, Inc. 398b
Hooker Electrochemical Co. 293
Houdry Process Corp. 27
*Hudson Engineering Corp. 117
Humphreys & Glasgow Ltd. 102

I

Ingersoll-Kalamazoo Division
Borg-Warner Corp. 133
*Ingersoll-Rand Co. 73
Insul-Mastic Corp. of America 79
The International Nickel Co. 134, 386
*Irving Subway Grating Co. 314

J

*Jerguson Gage & Valve Co. 320
*Johns-Manville Corp. 56, 158, 321
*Jones & Laughlin Supply Division 157
Jones, Tate & Co. Ltd. 102Cb
Jordan Corp.
Industrial Sales Div. OPW Corp. 330a

K

Kali-Chemie Aktiengesellschaft 291
*Keasbey & Mattison Co. 74
*The M. W. Kellogg Co. 42-43
The C. M. Kemp Mfg. Co. 20
Kinney Manufacturing Division
The New York Air Brake Co. 387
*Richard Klinger Ltd. 307
*Koch Engineering Co. 417
Koppers Co. 379
L. O. Koven & Bro. Inc. 154
*Krueger Engineering & Manufacturing Co. 350
The Kybernetes Corp. 95

L

*Lake & Elliot, Limited 102Ba
Lapp Insulator Co. 108
Lawrence Pumps, Inc. 360
Layne & Bowler, Inc. 295
Layne and Bowler Pump Co. 343
Leeds & Northrup Co. 151
Lewin-Mathes Co. 25
Luken Steel Co. 114-115
*The Lummus Co. 300
The Lunkenheimer Co. 67

M

*The Mack Iron Works Co. 406b
*Magnetrol, Inc. 371b
Manning & Lewis Engineering Co. 399b
Manning, Maxwell & Moore, Inc. 122-123, 325
The Marley Co. 65
*Jas. P. Marsh Corp. 45
Arthur G. McKee & Co. 418
*The Mercoid Corp. 364a
*Metal Propellers Ltd. 102Bb
Metallizing Engineering Co. 353a
*Metallo Gasket Co. 155
Midcontinent Tube Service, Inc. 406d
Milton Roy Co. 77
*Minerals & Chemicals Corp. of America 160
Minneapolis-Honeywell Regulator Co. 44
*W. K. Mitchell & Co. 11
*Mixing Equipment Co. 166
*Moncrief-Lenoir Mfg. Co. 398c
Monsanto Chemical Co. 9

N

*National Airoil Burner Co. 152, 333
National Aluminate Corp. 271
National Tube Division
United States Steel Corp. 313
New England Tank & Tower Co. 352
New England Valve Corp. 54
*The New York Air Brake Co. 387, 405
Newalls Insulation Co., Ltd. 103
Niagara Blower Co. 364b
*The C. W. Nofsinger Co. 299
*Nooter Corp. 165
*W. C. Norris, Manufacturer, Inc. 282
*Norton Co. 29

O

OPW Corp. 330a
*Oakite Products, Inc. 341a
The Ohio Injector Co. 93
*The Ohio Steel Foundry Co. 389
Oil Well Supply Division
United States Steel Corp. 7
The Okonite Co. 329
*Orbit Valve Co. 150

P

*Pabco Industrial Insulations Division
Fibreboard Paper Products Corp. 355
Pacific Tube Co. 87
Palmer Thermometers, Inc. 404
*Patent Chemicals, Inc. 39
*Peabody Engineering Corp. 344
Peerless Manufacturing Co. 149
*Penberthy Manufacturing Co.
Division Buffalo-Eclipse Corp. 100
Perfect Circle Corp. 377
Perkin-Elmer Corp. 38
*The Permutit Co. 118-119
*Petreco Division
Petrolite Corp. 383
*Petro-Chem Development Co. 390
*The Pfaudler Co. 146
*Phelps Dodge Copper Products Corp. 14-15
Philadelphia Gear Works 8
Plibrico Co. 371a
*H. K. Porter Co. 338
*Posey Iron Works, Inc. 341b
*Potter Aeronautical Co. 13
Horace T. Potts Co. 392b
The Wm. Powell Co. 139
Procon Incorporated 61
*Proportioneers, Inc.
Division B-I-F Industries, Inc. 2
Puget Sound Fabricators, Inc. 353b
The Pyle-National Co. 290

R

*R-P & C Valve Division
American Chain & Cable Co. 148
*The Refinery Catalog 280-281
Refinery Supply Co. 349b
*Geo. P. Reintjes Co. 398e
*Revere Copper and Brass Inc. 129
Reynolds Metals Co. 85
W. S. Rockwell Co. 412a
*Rockwell Manufacturing Co. 394-395
*Rockwood Sprinkler Co. 40, 339
The Rolo Engineering Co. Ltd. 102A

S

*Sarco Co. 275
Schott Brothers Co. 406e
*Schuler Manufacturing Co. 376
Schutte and Koerting Co. 353c
*Scovill Manufacturing Co. 64
Sealol Corp. 349a
Service Foundry Division
Avondale Marine Ways, Inc. 345b
Shand & Jurs Co. 33
Sheffield Division
Armco Steel Corp. 144
*Sier-Bath Gear & Pump Co. 328
*S. Morgan Smith Co. 324
Solvay Process Division
Allied Chemical & Dye Corp. 51
Southern Engine & Pump Co. 353d
Southwestern Engineering Co. 142, 316
Speedline Stainless Steel Fittings
Div. Horace T. Potts Co. 392b
August Spindler & Sons Inc. 412b
Standard Oil Co. of California 17
Stauffer Chemical Co. 385
Stone & Webster Engineering Corp. 365
*Strahman Valves, Inc. 276
*Stratford Engineering Corp. 101
*Sun Shipbuilding & Dry Dock Co. 289

T

*Taylor Instrument Companies 130-131
Tennessee Coal & Iron Division
Unitd States Steel Corp. 96, 313
*The Terry Steam Turbine Co. 58
The Texas Company 138
Texas Metal Fabricating Co. 356
Arthur Tickle Engineering Works 392a
The Timken Roller Bearing Co. 16
Tracerlab, Inc. 361b
*Tretolite Co. 145

U

Uniflow Valve Corp. 399a
*Union Asbestos & Rubber Co. 41
Union Wire Rope Corp. 57
*United States Gauge Division
American Machine & Metals, Inc. 372
*United States Rubber Co. 269
United States Steel Corp. 7, 71, 96, 313, 347
United States Steel Export Co. 96, 313, 347
United States Steel Supply Division
United States Steel Corp. 96, 313
*The United States Stoneware Co. 97
*Universal Atlas Cement Co. 71
Universal Oil Products Co. 112, 326

V

Visco Products Co. 147
*Henry Vogt Machine Co. 318-319
*J. H. H. Voss Co. 405a
*Vulcan Manufacturing Division
Vulcan-Cincinnati, Inc. 52

W

*W-S Fittings Division H. K. Porter Co. 338
The E. H. Wachs Co. 408b
Wagner Electric Corp. 50
Walworth Co. 26
Warren Petroleum Corp. 334
Wedgeplug Valve Co. 47
West Instrument Corp. 330b
Western Supply Co. 323
*Weston Electrical Instrument Corp. 48
Wheaton Brass Works 66
The Whitlock Manufacturing Co. 10
John Wiley & Sons, Inc. 287
A. R. Wilfley & Sons, Inc. 75
T. D. Williamson, Inc. 322
*Thomas C. Wilson, Inc. 46
*Wolverine Tube Division
Calumet & Hecla, Inc. 331, 332

Y

*Yarnall-Waring Co. 373
*Otto H. York Co. 362

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.
2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.
3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

Quick–Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

•

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS U. S. A.

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

PETROLEUM REFINER Readers' Service Card — May, 1957, Issue*

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25	E26	E27									

ADVERTISEMENTS—Circle page number of ad for more products information:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	102A	102Ba	102Bb
102Ca	102Cb	102Da	102Db	102Dc	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
138	139	140	141	142	143	144	145	146	147	148	149	150	151	052	153	154	155	156	157
158	159	160	161	162	165	166	168	269	271	273	275	276	277	278	279	280	281	282	283
284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	302	303	307
310	311	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330a
330b	331	332	333	334	337	338	339	341a	341b	342	343	344	345a	345b	346	347	348	349a	349b
350	351	352	353a	353b	353c	353d	354	355	356	358	359	360	361a	361b	362	363	364a	364b	365
366	367	368	369	370	371a	371b	372	373	374	375	376	377	378	379	380	381	382	383	384
385	386	387	388	389	390	391	392a	392b	393	394	395	396	397	398a	398b	398c	398d	398e	399a
399b	404	405a	405b	406a	406b	406c	406d	406e	406f	407a	407b	407c	408a	408b	409a	409b	410	411	412a
412b																			

Name (Please Print) _____

Company _____ Position _____

Address _____

*MAY ISSUE CARD EXPIRES JULY 31, 1957

Check Square for Extra Card ☐

use these

READERS' SERVICE CARDS

for more information

Here is a quick, convenient way

to get more information on New Equipment and Literature reviewed in the editorial columns and on products and services advertised in this issue of PETROLEUM REFINER:

1. For more data on New Equipment, Catalogs and Literature reviewed in the editorial columns, circle on the card below the Code Number shown in the item itself.

2. For more data on Advertised Products and Services, circle on card the actual page number of the advertisement as listed in the Advertisers' Index on the preceding page.

3. Then, print your name, title, company and complete mailing address and drop the card in the mail. PETROLEUM REFINER's Readers' Service Department will promptly forward your requests to the company concerned. The requested information will then be mailed directly to you.

PETROLEUM REFINER Readers' Service Card — **May, 1957, Issue***

EDITORIAL ITEMS—Circle code numbers on which more information desired:

E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25	E26	E27									

ADVERTISEMENTS—Circle page number of ad for more products information:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	102A	102Ba	102Bb
102Ca	102Cb	102Da	102Db	102Dc	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157
158	159	160	161	162	165	166	168	269	271	273	275	276	277	278	279	280	281	282	283
284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	302	303	307
310	311	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330a
330b	331	332	333	334	337	338	339	341a	341b	342	343	344	345a	345b	346	347	348	349a	349b
350	351	352	353a	353b	353c	353d	354	355	356	358	359	360	361a	361b	362	363	364a	364b	365
366	367	368	369	370	371a	371b	372	373	374	375	376	377	378	379	380	381	382	383	384
385	386	387	388	389	390	391	392a	392b	393	394	395	396	397	398a	398b	398c	398d	398e	399a
399b	404	405a	405b	406a	406b	406c	406d	406e	406f	407a	407b	407c	408a	408b	409a	409b	410	411	412a
412b																			

Name (Please Print)_____

Company_____ Position_____

Address_____

*MAY ISSUE CARD EXPIRES JULY 31, 1957 — Check Square for Extra Card ☐

Circle code number for more data on "New Equipment" editorial items

Circle page number for more information on ADVERTISED products

Postage Will be Paid by Gulf Publishing Company

No Postage Stamp Necessary if Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 7 (Sec. 34.9, P. L. & R.), Houston, Texas

PETROLEUM
REFINER

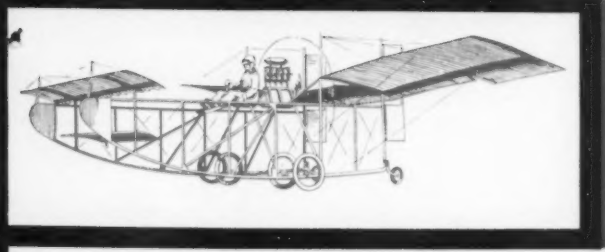
BOX 2608

HOUSTON 1, TEXAS U. S. A.

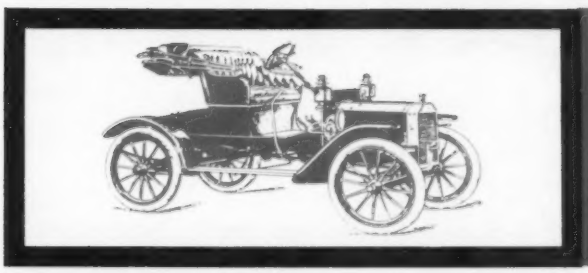
Quick—Easy

Use these cards to help keep informed on what's new . . . for more job-help information on equipment and services.

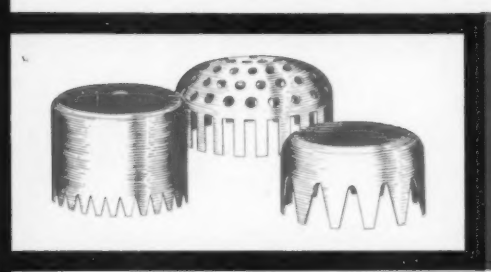
there's been

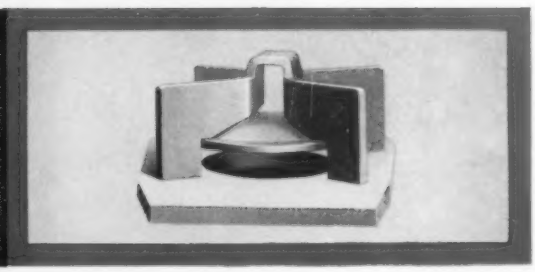


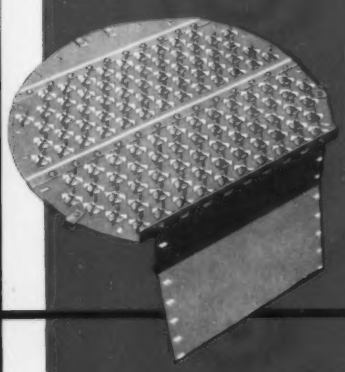
some changes made



in fractionating trays, too!







REPRESENTATIVES

Today's trend in progress is away from "horse-and-buggy" bubble trays to Koch's jet-age **FLEXITRAY** . . . and, for good reason!

With "Flexitray," the entire tray area is available for vapor-liquid breakout . . . no obstruction to liquid flow exists . . . vapor separates at lower velocities. "Flexitrays" remain cleaner – longer!

With its extreme flexibility and capacities, it is small wonder that major companies – looking for the best designed trays – have adopted "Flexitray" for more than 400 **NON-CAPTIVE** installations.

Write . . . wire . . . phone your nearest Koch representative or:

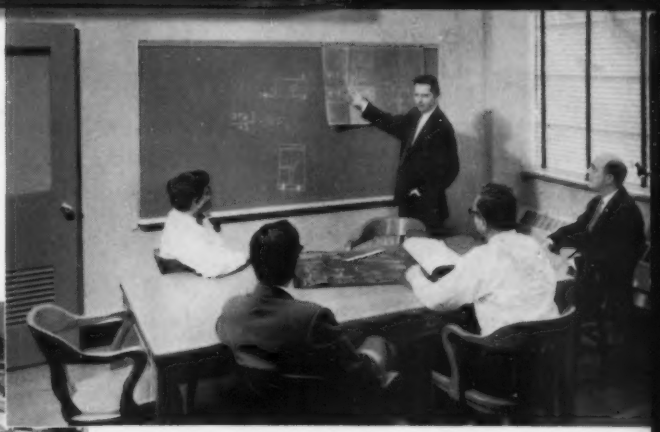
KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS

321 WEST DOUGLAS AVENUE, WICHITA 2, KANSAS

Eastern Representative: F. J. McConnell, 122 E. 42nd Street, New York 17, N. Y.
Tulsa, Oklahoma Representative: W. C. Myers Company, Wright Building
Houston, Texas Representative: Alpha Engineering Company, P. O. Box 12371
Pittsburgh, Pennsylvania Representative: D. D. Foster Company, 501 Alcoa Building
West Coast Representative: Jacobs Engineering Company, Pasadena: RYan 1-9373; Oakland, TEmplebar 2-5391
Illinois Representative: M. B. Fisher, 1521 Courtland Avenue, Park Ridge, Illinois

PROBLEM

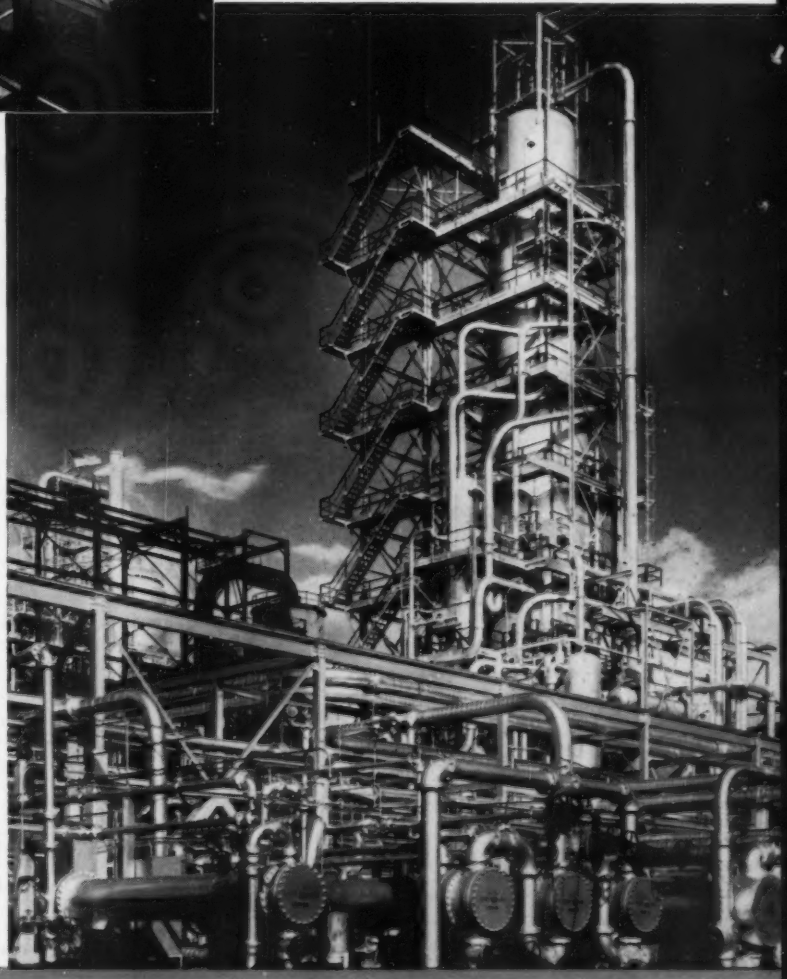


SOLUTION

RESULTS

YOU'LL get the completely satisfactory results you can expect on your project when you employ the diversified knowledge, world-wide experience and specialized talents of engineers in the McKee organization.

McKEE BUILDS PLANTS THAT EARN PROFITS



McKee
ENGINEERING & CONSTRUCTION
Services

Arthur G. McKee & Company • Engineers and Contractors
Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto